THE PLAYER-PIANO UP-TO-DATE

A Comprehensive Treatise on the Principles, Construction, Adjustment, Regulation and Use of Pneumatic Mechanisms for Piano-Playing together with

A Description of the Leading Mechanisms now in Use and Some Hints on the Playing Thereof

BY

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ILLUSTRATED

EDWARD LYMAN BILL
PUBLISHER
373 FOURTH AVENUE NEW YORK

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FROM THE PUBLISHER

As a publisher for many years of music trade technical literature, it has been my aim at all times to supply information of a reliable and educational character.

The development of the player-piano has brought about new conditions and its constant growth is creating new and increasing demands for technical information.

When I published "A Technical Treatise On Piano And Player Mechanism," some years ago, it created wide-spread interest because it was the first book ever published dealing directly with the player-piano. Since that time I have published a number of books by the same author, among which I might mention two which deal directly with the player-piano: "Regulation And Repair Of Piano And Player Mechanism" and "The Player Pianist." These books have fulfilled a useful mission, but the time has come when work of enlarged scope shall be produced, dealing comprehensively with the principles of construction, adjustment, regulation and use of pneumatic mechanisms for piano playing. Hence, following this belief we

have been at work for some time upon the preparation of "The Player-Piano Up-to-Date."

This book deals with the fundamental principles of pneumatic mechanism, explaining the physical laws involved, with chapters on player construction, and deals comprehensively with the current practice, with the music roll, with the adjustment and care of player mechanism, and provides a detailed description of some of the leading mechanisms now in use.

I feel confident that "The Player-Piano Up-to-date" will meet with the approval of the practical men of the trade, particularly dealers, repairers and tuners, and I may add salesmen as well, because it places within reach of readers a wealth of player detail which is extremely desirable for all interested.

The author, in the preparation of "The Player-Piano Up-to-date," has carefully examined the principal player systems, and as a result of study and research, combined with an accumulated technical knowledge, he has produced a volume which I think constitutes the most valuable treatise on piano-player mechanism ever produced.

Of course it will be readily admitted that the player-piano industry is in an evolutionistic con-

dition and it is observed that many changes occur from time to time in the mechanism of piano-players, so that to keep up with the changing conditions it is necessary to produce frequent works upon the subject with which this book treats.

The necessary peculiarities of player construction give rise to certain problems and I feel that in a degree this publication will simplify those problems, particularly for the tuner and repairer who is operating at a distance from the factory.

The rapid ascendancy of the player-piano in popular favor has been so astonishing within the past few years, that there really has been a dearth of player experts who are capable of solving the ordinary problems of adjustment, regulation and repair. Hence, the value of a reliable source from which such information may be gleaned, will be at once recognized.

I may say that the author outlined this book more than a year ago, but the necessary work has occupied a much longer period than was first considered sufficient.

The player-piano to-day is not merely a factor in the piano industry, but it is a powerful force and one which is concededly growing all the while.

There are many who believe that only a short

time will elapse before practically all of the pianos put forth in this country will contain some form of player mechanism, and that in days to come the upright piano without player mechanism will take the position long occupied by the square piano.

That prediction will have to be verified by conditions demonstrated by the events of the future, but the fact remains that the player-piano is growing tremendously in public favor, and the interest has become daily accentuated by reason of the fact that the continuous advertising put forth by the great houses has stimulated and aroused increased attention on the part of the music loving public.

That the player-piano has been, and will continue to be, a great factor in the musical development of the nation, is admitted by all who are acquainted with its marvelous powers.

It may be truthfully said that the opposition which existed in professional quarters years ago towards music produced through various mechanisms has largely, if not wholly, disappeared and the professional musicians to-day are becoming rapidly converted to the use of the player-piano in connection with their professional duties.

The player has opened up new possibilities in

the world of music, and it is rapidly growing in the estimation of the music loving public, as its true functional powers and possibilities of musical interpretation are better understood.

"The Player-Piano Up-to-date" will aid in player development. It will impart a knowledge upon technical matters to those who desire it, and I feel that its purpose is helpful—its mission useful—and its influence permanent.

EDWARD LYMAN BILL.

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AUTHOR'S PREFACE.

The custom which permits an author to explain such features of his conception or his work as may not be apparent immediately furnishes the reason for the following words.

In preparing this treatise, I have not been unmindful of the practical necessities of the piano trade, of the piano tuner, and of the band of men who are so earnestly devoting themselves to the development of the player-piano mechanism. But I am equally mindful that our interests are not invariably best understood by ourselves. Particularly I have seen the essentiality of a standard of statement as to theoretical principles and as to terminology; a standard which the practical men have hitherto rather lamentably failed to provide.

Moreover, in designing the first part of this book as a succinct but rigid statement of physical laws, I have considered mainly the need for theoretical accuracy, combined with the peculiar requirements of men who, as a class, have little or

no scientific training. The first part of the work is therefore deliberately devoted to principles, and to these alone.

In Part 2, I have been content to make extended and careful explanations and descriptions of methods, basing these strictly upon the principles developed in Part 1, and adhering carefully to the terminology adopted; which latter will, I hope, meet with general approval.

Part 3 is devoted entirely to descriptions of individual mechanisms. These have been classified according to the simple methods set forth in the body of the book, and I have confined my efforts to general descriptive work, expressing no opinion as to merits or the reverse.

The remainder of the book is devoted to remarks on certain special mechanisms and to some general considerations on regulation and repair.

I have designed this book mainly for the practical man. The man of physics will blame me for being too practical, and the practical man for being too scientific. Both are right, and both wrong. I have tried to steer a middle course, and I bespeak now from all readers that favorable consideration which I have come, through pleasant experience, to expect at the hands of

those who work alongside me in the realm of pneumatics.

WILLIAM BRAID WHITE.

PART I

THE FUNDAMENTAL PRINCIPLES OF PNEUMATIC MECHANISM

Chapter I.

The prevailing type of playing mechanism for pianos and kindred musical instruments is pneumatic. In pneumatic machines the energy required for their operation is provided from the force of atmospheric air. In order that any force at all may be exerted by atmospheric air, it is plain that the particular quantity of air upon which at any moment the action of the mechanism depends must be in some way differentiated from the air surrounding it. In fact, in order to exercise any energy in the form of work, it must either be more or less powerful than the air which surrounds it. If more powerful, it will act directly upon the mechanism. If less powerful it will act indirectly, by producing a state of affairs within the mechanism whereby the balance or equilibrium between the air inside and that outside will be disturbed, and the exterior air will find itself in a condition where it can exercise its normal pressure effectively.

To reduce the statement to concrete terms, pneumatic machinery of any kind must obtain its

power for work either by increasing or by diminishing the pressure of air. In the first case, we have what is known as a compression machine, wherein a body of air is compressed and caused to expend its super-normal pressure in doing work. In the other case, we have what is called a vacuum machine, wherein air is reduced in pressure by having its quantity reduced, so that the normal-pressure air exterior to it may do work through the disturbance of equilibrium thus set up.

The air around us appears to be still, calm, inert and powerless; unless indeed set in motion artificially. Nevertheless, we are conscious that winds blow and that their power is sometimes enough to set enormous waves of water into violent and destructive activity. If we consider the reason for the existence of winds in a medium so transparent and apparently weightless, we are bound to assume that the reason lies in some disturbance of equilibrium or balance between regions of the atmosphere more or less widely separated, whereby quantities of air are caused to flow from one region to the other. And the impression is deepened when we read in weather reports pre-

dictions based upon comparisons of the high-pressure and low-pressure areas subsisting at any moment over one or another part of the country.

The impression, then, cannot but be borne in on us that the air of the atmosphere is something more than a mere weightless, inert intangibility, even supposing that we can conceive the idea of anything existing without any weight at all. And when we consider more closely the facts of the case, as developed in the science of physics, we find it necessary to revise all estimates based on mere visual or tactual observation.

We find, in short, that the air of the atmosphere is a more or less dense body of gases, of which the principal is oxygen, forming a great aerial sea 29 miles deep, whereof the bottom is the surface of the earth. It is plain enough that a great mass like this, even though it be composed of gases exceedingly light, must have some weight. Moreover, it becomes clear on reflection that the parts of this air which are nearest to the earth's surface must be in a state of more or less compression.

The conception of the air as having weight and density, is found by experiment to be entirely cor-

rect, and to represent the actual condition of affairs. In point of fact, the pressure of the air at the sea level, where it is greatest, is not less than 14.75 lbs. to the square inch; a pressure exercised continually and in all directions.

It is plain that this pressure is greatest at the sea level, since this is the bottom of the great aerial ocean. And it is equally clear that the higher we ascend in this aerial ocean, the less will be the pressure of any given mass of air. Our lungs are constructed so that they can inhale and exhale air most conveniently when its pressure is that of the sea level, as every mountain climber knows.

If the normal pressure of the air (14.75 lbs. to the sq. inch) were exercised only upon the outside of our bodies, the results would be, to say the least, markedly unpleasant. But the fact is that the pressure is exercised both externally and internally, in such a manner that a state of equilibrium or balance is maintained, and so the pressure in one direction is completely neutralized by the equal pressure in the opposite direction. We therefore feel no inconvenience whatever.

Nevertheless, it is plain enough that the mere fact of there being this condition of high pressure

in the normal air is enough to give us an agent powerful for the doing of work, if only it can be utilized. The example furnished by our body, as above explained, teaches us that so long as a balance or equilibrium is maintained, the pressure of the air is negligible and useless for the doing of work. It is plain therefore that, in order to use this air pressure for any efficient end on any movable body, we must disturb the equilibrium between the air outside the body and the air inside it. Naturally, this can be done in two ways. The internally contained air may be compressed so that its pressure is higher than that of the external air. Or the internally contained air may be reduced in quantity so that the pressure of what remains is lower than normal. In either case the balance is disturbed, so that a force equivalent in efficiency to the difference between the pressures of the external and the internally contained air is set in activity.

In order, however, to understand how air may have its pressure increased or lowered, we must realize that it is a property of gaseous bodies completely to fill any space in which a given volume of them may be placed. Thus, suppose that we

have a quantity of air of which the volume is one cubic foot at normal pressure. In other words, suppose that we could carve out of the atmosphere a block of air in the shape of a perfect cube of which each side measures one foot. That would be a cubic foot of air at normal or atmospheric pressure. Now, it is obvious that if we built around this block of air a wooden box completely covered on all sides and having exactly the same internal measurements, our cubic foot of air would be very comfortably contained, and would fill the whole box completely. If our block of air were like a block of wood or iron, however, there would be a different state of affairs in case we should suddenly enlarge the box without letting any more air in. If we now enlarge our box while still keeping its contents sealed up from external contact, it is plain that the imaginary block of air must either leave a vacant space in the now enlarged box or else expand until it fills the larger space as completely as it filled the smaller. The latter is what actually happens. The air which has filled the volume of one cubic foot will expand when its container is enlarged, until it fills the increased volume. But it cannot do this without losing in pressure what it gains in volume.

Thus if a cubic foot of air at normal pressure is contained in a box of the same dimensions, and if that box is then enlarged to four times its previous volume, it follows that the contained air (if none is permitted to gain access from the outside) must necessarily expand to fill four times its previous volume, so that its pressure will be one fourth of what it was before. That is to say, the body of air after expansion will press upon each square inch of area of the box with one fourth of the force wherewith it pressed when the box remained in its original condition.

Now, it is easy to see that if such a condition of reduced pressure is brought about in the interior of a box, the normal pressure of the external air can be turned to account for the doing of work. Suppose the previous case, where the pressure of the internally contained air has been divided by four. Approximately, that means that the internally contained air now exercises a pressure of approximately 3.69 lbs. to the square inch instead of 14.75 lbs. Obviously, then, there will be a difference between the external and internal pressures equal to the difference between 14.75 and 3.69. In other words, the external air will exceed in pressure to the extent of 11.06 lbs. to the

square inch. Or, again, the external air will have 11.06 lbs. of pressure to the square inch exerted against the outside of the box as an active force in excess of the entire internal pressure. (Incidentally, it should be noted that, to expand a cubical box of 1 cubic foot volume to 4 cubic feet volume, the dimensions of each side would have to be increased from 1 ft. to 1.5874 ft. in each dimension.)

Such a force, naturally, can be used to perform work. The pneumatic piano playing mechanism represents a concrete expression of this possibility. Other concrete expressions are represented by the ordinary pump, by the vacuum brake, the vacuum cleaner and other similar machines.

Now, let it be understood at the outset that this force of which we have spoken is a positive active force. It is customary to refer to the piano playing mechanism as depending upon "vacuum" for its energy, and technical experts frequently commit the unpardonable sin of talking about "vacuum" as if "vacuum" were a force capable of performing work. What these persons mean, of course, is that when any part of a given volume of contained air is withdrawn, and the remainder

expands, there occurs a partial "vacuum," in the sense that the space is rather "emptier" than before, though only by reason of being occupied by air which is thinner than before. An actual "vacuum" that is a total "emptiness," is a physical impossibility. Moreover, if it were possible it would be useless of itself. Emptiness cannot exercise a force, for it is simply the negation of something. When people talk about "vacuum" the impression is bound to remain that the withdrawal of part of the air from an interior, or the enlargement of an interior without increasing the amount of contained air, will leave a space in which there is the original quantity of air in juxtaposition to a space in which there is nothing at all. If such a condition could exist, there would be such a thing as a "vacuum." Air, however, expands, and fills all spaces, though at varying pressures, as above described.

It is not, therefore, the so-called "vacuum" which does work, but rather the external air. The fact that internal pressure is reduced simply means that the external air is given an opportunity to use its normal pressure to do work. Thus, the "vacuum" is but the indirect means whereby work is done; the medium by the existence

whereof the external air can make use of its normal pressure.

Plainly, from what has been said above, the first and essential requirement in a machine that is to be actuated by external air pressure, is an arrangement whereby the pressure of air contained inside a closed box may be reduced, or, to put the matter in another way, whereby given quantities of the contained air may be withdrawn so as to permit the expansion of the remainder continually from higher to lower pressures. Precisely this is the object attained by the familiar bellows, known to us all in the reed-organ, and since applied, with modifications and refinements, to the player mechanism.

In order that the reader may understand thoroughly the exact process of pressure-reduction with the bellows, it is necessary to recur to our previous illustration of the closed box. Let us imagine once more a closed hollow box, containing air, which through connection with the atmosphere has been maintained at normal atmospheric pressure. It is plain that neither the contained nor the external air can perform any work as things are. Suppose however that one side of this box can be stretched out until the in-

terior dimensions of the whole are greater than they were at first. Suppose also that at the moment of beginning this stretching, the opening to the atmosphere is sealed. Plainly, the contained air will receive no accession of volume from outside, and will therefore necessarily expand until it entirely fills the new and enlarged space. As it expands its pressure is reduced. This is precisely the process which occurs when the bellows of a playing mechanism are operated. The bellows system consists primarily of two exhaust units, each operated by a foot pedal. Each consists of two large wooden panels, hinged at one edge and with a covering or leaf of rubber cloth or some similar material between the panels. It is plain that such a device is in effect a closed box which may be shut tight or expanded, at will. The bellows unit thus described is connected with the other parts of the player mechanism which also are adapted to contain air, and is held shut, when in normal position, by means of a compression spring.

Now, when the player-pianist presses a foot on one of the pedals which are connected with the two exhaust units, he opens the unit, and thus simply enlarges the area in which a given quantity of

air was contained. This area, of course, includes whatever parts of the mechanism are connected with the exhaust unit. When the area is enlarged by the opening of the unit through the foot, the contained air expands, so that its pressure is diminished. That which is nearest to the newly opened area is naturally rather higher in pressure than that which is more remote, on account of the fact that it is at the bottom of the mass and supports the weight of all the air above it. Hence, it will push open the escape valve at the outer side of the exhaust unit and will pass into the open air. As soon as this happens, the external pressure of air on the valve against the reduced pressure within, will operate to close the valve and prevent any more air from entering the unit. In this manner, the pressure of the contained air will be progressively reduced, as its quantity is gradually lessened in the manner described.

Now, we all know that the motion of the bellows units is reciprocal, in that the feet press the pedals alternately. Thus there will come periodically a time when one unit is entirely open and the other entirely closed; a fraction of a second during

Some compensatory device is therefore necessary, in order that the work of the pressure-reducing machinery may be continuous. This is provided in a very ingenious manner by means of what is erroneously called a "reservoir," although it should be called an equalizing unit.

At this point it might be well to call attention to the fact that the technical language which is habitually applied to the description of player mechanism is characterized by lamentable looseness. It is customary, for example, to speak of the exhaust units of the bellows system as "feeders" and of the equalizing unit as a "reservoir." Now, obviously, "feeder" means something that supplies, increases, or furnishes. "Reservoir," just as certainly, means a storage place of some sort. Yet we well know that the player mechanism is operated by a bellows-system of which the object is to withdraw air, not to store it up. The terms "feeder" and "reservoir" would be correct if applied to a compression machine, where the pressures used are above atmospheric, but are ridiculous when applied to sub-normal-pressure apparatus like that which we have been discussing.

The equalizing unit is simply an automatic

auxiliary exhauster. In other words, it is the same sort of thing as an exhauster, but is normally held open instead of shut, by means of a spring. It is in direct communication with the exhausters and with the rest of the mechanism. When the pressure of air in the mechanism is reduced, the process of reduction extends, of course, to the equalizer. Hence, the latter tends to close as soon as the pressure inside it is reduced enough to permit external air pressure on its moving wall to overcome the strength of the expansion spring. When, however, there comes the momentary pause in the work of the exhausters, when in fact one exhauster is entirely closed and the other entirely open, the internal pressure in the equalizer begins again to approach normal, due to the pressure of the mass of air within the rest of the mechanism, which for the fraction of a second is not being further reduced. As soon as this happens, that is to say as soon as the equalizer begins to open again, it becomes of itself an exhauster, opening a larger area for the expansion of the contained air and thus carrying on the work until the exhausters are again performing their functions. Thus the equalizer is not alone a governor, but an automatic compensator, since the rapid-

ity of its operation is in direct ratio with the rapidity of motion of the exhausters.

Thus, in essentials, is the work of the pressure-reducing apparatus or bellows-system of the player mechanism carried on. One further point should be noted. The more rapidly the feet operate the pedals, the more rapidly is the internal pressure reduced. Hence the greater at any given time is the excess of the external over the internal pressure. Hence again, as explained below, the greater is the pressure on the moving walls of the power pneumatics which operate the piano action. And hence, once more, the intensity of blow upon the piano hammers through the piano action is in direct ratio with the rapidity wherewith the footpedals connected with the exhausters are operated by the feet.

The bellows-system of the player mechanism, therefore, is seen to be essentially a pressure-reducing apparatus. It now remains for us to consider the manner in which the selecting and operating parts of the player mechanism co-act with various parts of the piano action. In making the explanation which follows the principles only will be considered and the mechanism will be treated, as already before in the case of the

exhausters and equalizers, in ideal form. C nstructional detail will be considered in later chapters.

Imagine then that the pressure-reducing apparatus already described is connected by means of a pipe with another box containing air. Suppose that along one side of this box are ranged numerous small bellows units from 3½″ to 4″ long and perhaps 1½″ wide. Suppose that each of these small "pneumatics" has one movable and one fixed wall. Suppose further that each is placed in communication with the large box by means of a hole drilled through the side of the latter into the interior of the former. Now, it is plain that in such a case, the effect of a continued withdrawal of contained air from this large area by means of the pressure reducing apparatus below will be to reduce the internal pressure in such a way that the external air pressing upon the movable walls of the pneumatics will cause the former to collapse upon the fixed walls. Or, in other words, all the pneumatics would collapse at once, and if they were connected with the moving parts of a piano action, all the notes of the piano would be sounded simultaneously, and would remain in vibration until the internal and

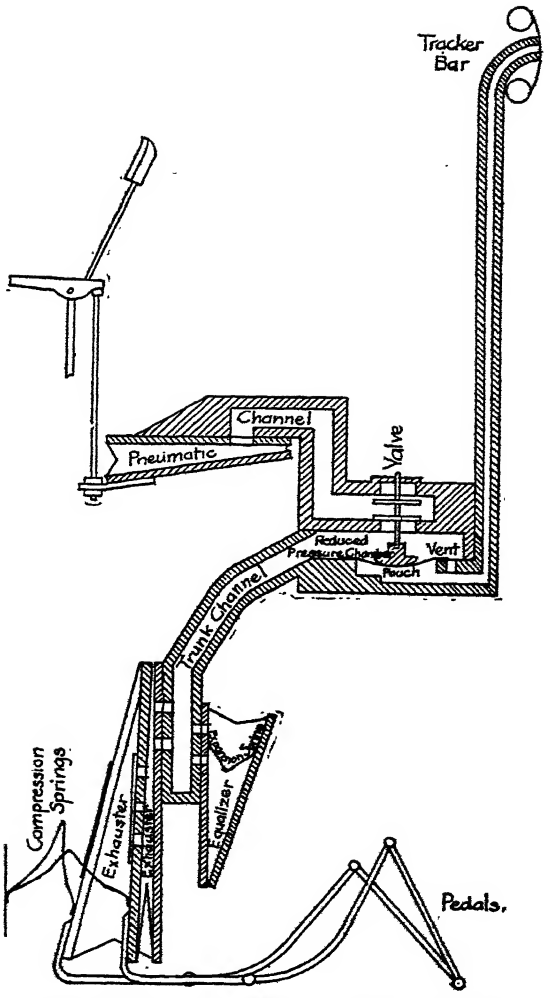

FIG. 1. IDEAL SECTIONAL VIEW OF PNEUMATIC MECHANISM; PNEUMATIC OPEN (PARTS NOT IN PROPORTION)

external pressure had been equalized again by some appropriate means, as by letting external air into the mechanism.

Plainly this would not do, without some means for selecting the pneumatics which are to collapse at any given moment, according to the pre-determined requirements of a piece of music. A selecting device is therefore used, of considerable ingenuity, though perfectly simple in principle. At this point, refer to the illustrations figs. 1 and 2.

Let us suppose that between each of the pneumatics and the large box common to all there is interposed a valve, which in one position connects the pneumatic with the interior of the box while shutting out the open air, and in the other position connects the pneumatic with the open air while shutting off all communication with the box. Let us also suppose that each valve moves in a chamber either connected with or part of the large box in which the pressure is reduced. Suppose also that underneath each valve is a pouch and that on the other side of each pouch is a tube running to a metal bar where all the tubes are gathered. Suppose again that, by means of a very small communicating passage, the area of

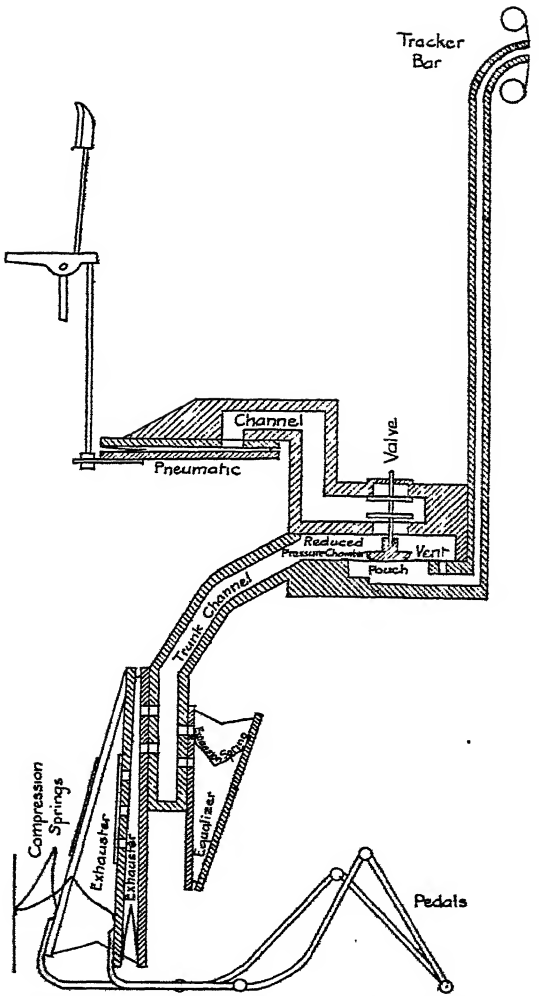

FIG. 2. IDEAL SECTIONAL VIEW OF PNEUMATIC MECHANISM; PNEUMATIC OPEN (PARTS NOT IN PROPORTION)

each tube and of the little chamber roofed by the pouch into which each tube runs is exposed to the pressure-reducing activities of the large box. Suppose once more that the hole in which the tube ends on the metal bar is sealed, as by a piece of paper stretched over it.

Now plainly, the following conditions will prevail. The bellows being operated, the contained air in the large box will be reduced in quantity and will expand to lower pressure. The same condition of pressure will prevail in the tubes and under the pouches by means of the small communicating passages above mentioned, the outer ends of the tubes being sealed. The valves therefore which open and shut the pneumatics to the open air and to the internal pressure area of the box will remain fast on their seats, being held down by the external air pressure on the outside of them. The pneumatics therefore will be shut off from the box and will remain open.

The points here discussed will be made clear upon examination of the illustrations (figs. 1 & 2).

Now, suppose that the outer end of one tube is opened, as by the paper traveling over it, until a hole therein registers with the tube aforesaid. Immediately, the outer air will rush into the tube,

the air-pressure in which has been reduced, and will bear against the pouch, throwing the latter upwards and raising the valve. The latter will at once shut off the outer air from the corresponding pneumatic and will simultaneously open communication between the interior of the pneumatic and the interior of the large box (which we may now call the reduced-pressure chamber). At once, therefore, the normal pressure air in the pneumatic will rush out into the reduced pressure chamber, and expand there until the pressure has been equalized between chamber and pneumatic. The chamber being much larger, the resultant pressure will be sub-normal, so that the external pressure will force upwards the movable leaf of the pneumatic and thus operate the piano action.

If now the hole passes over the tube and the paper again seals up the latter, the small communicating passage (generally called the vent) between the tube-pouch-chamber area and the reduced-pressure chamber, will expose the former to the reduced-pressure process in the chamber. Hence the pressure will again be reduced in the tube-pouch-chamber area, whereupon the pressure which has been holding up the pouch and valve

against the external pressure on the outside of the latter, will disappear, and the valve will again return to its seat, being held firmly down by the external pressure on its outer disk. Hence again, the pneumatic will be cut off from the reduced-pressure-chamber and exposed to the outer air. Immediately, the pneumatic will be filled with normal pressure air and will open. This process may be repeated as often as holes pass over any given tube at the metal bar (generally called the tracker bar.) The illustrations (Figs. 1 & 2), will make all this quite plain.

The rapidity of pneumatic collapse will be in direct ratio with the rapidity of foot work on the pedals, as explained before, and hence the intensity of blow on the piano action will be in similar ratio. The rapidity of the general process of playing also—that is, the speed at which a given piece is played—will depend upon the rapidity wherewith the sheet of paper or music-roll is drawn across the tracker-bar.

This, in outline, is the principle of pneumatic playing mechanism. The details of construction and design will be considered in the next chapters, in which also the operation of the pneumatic motor and accessory devices will be discussed.

PART II

PLAYER CONSTRUCTION

Chapter I.

THE PRESSURE-REDUCING APPARATUS OR BELLOWS SYSTEM.

The bellows-system of the pneumatic piano-playing mechanism is, in every sense of the term, the "power-plant." Its importance is prime, for upon its effiiciency depends the successful or non-successful operation of the whole player. In the present chapter it is intended to give a general description of the design and construction of such systems, to the end that the student may thoroughly understand the differences which are seen to exist in the practice of various manufacturers. It will be seen that all bellows-systems, no matter by whom made, are properly to be divided into two grand classes, and that within one or other of these divisions every type may be classified. It will also be seen that the divisions themselves exist on account of differing views as to the expressive capacity of the player mechanism, and that the general design of the latter is largely, and in fact essentially, influenced by

the theory which the constructor holds as to the proper functions of the bellows.

In order that the reader may fully understand the nature of the distinctions which I am about to explain, it is necessary that the exact duties of the bellows-system should be clearly in mind. It must be remembered, in fact, that these functions are two-fold. On the one hand, the bellows-system supplies the power for the general functioning of the mechanism, by lowering the air pressure in the chests and motor, and so enabling the operation of the playing mechanism through the medium of the perforated controlling sheet. On the other hand, the bellows-system is deliberately designed so that the level of pressure shall continually be shifting, that is to say so that the given quantum of power at any moment existing may be altered. The object of this modification is to permit the production of differences of intensity in the collapse of the pneumatics, to the end that some notes may be sounded louder than others according to the aesthetic demands of the music. The distinction which I make between the two grand divisions into which all bellows-systems fall depends upon whether these differences in intensity are produced directly through the ex-

hausters of the bellows or indirectly through auxiliary mechanism.

The distinction here set forth is recognized by player designers when they speak of bellows-systems as being either "sensitive" or "non-sensitive." The definition is, however, hardly clear enough. It would be better to use terms less ambiguous and liable to misunderstanding. All bellows-systems permit of variations in the lowering of pressure. The difference is in their method of operation. It would, I think, be better to use the terms "direct-variation" and "indirect-variation"; and these I shall employ throughout this work.

The constructional differences between bellows-systems of the direct-variation and indirect-variation types respectively are found in the relative dimensions of the exhaust and equalizer units, in the comparative strength of the expansion and compression springs, and in the inclusion or omission of auxiliary governors for controlling the pressure reduction in the playing action. The last item is of controlling importance in forming the distinction here laid down. In fact I shall generally proceed on the assumption that bellows-systems are of the direct-variation type when

they have no such auxiliary expression governors, and of the indirect-variation type when they are so fitted. The context will indicate that the distinction is rightly made. Other distinguishing differences will of course also be noted.

The general make-up of the direct-variation type of bellows-system may be easily described. There are two exhausters, one equalizer, light expansion and compression springs, and a simple auxiliary equalizer for the motor, but no auxiliary equalizer for the playing action. The general idea which influences this design is that of direct foot-control. The variations in pressure-level required for the necessities of practical piano playing are to be obtained entirely through the direct operation of the exhausters by the feet. Hence these systems are designed so that all foot-work may be performed easily and without fatigue. Hence, units are smaller, compression springs lighter, equalizers less ponderous and expansion springs less stiff, than is considered desirable when the indirect system is used.

The illustration (Fig. 3), shows a direct-variation bellows-system with its various elements displayed. The reader is asked particularly to note the relative dimensions of the equalizer and the

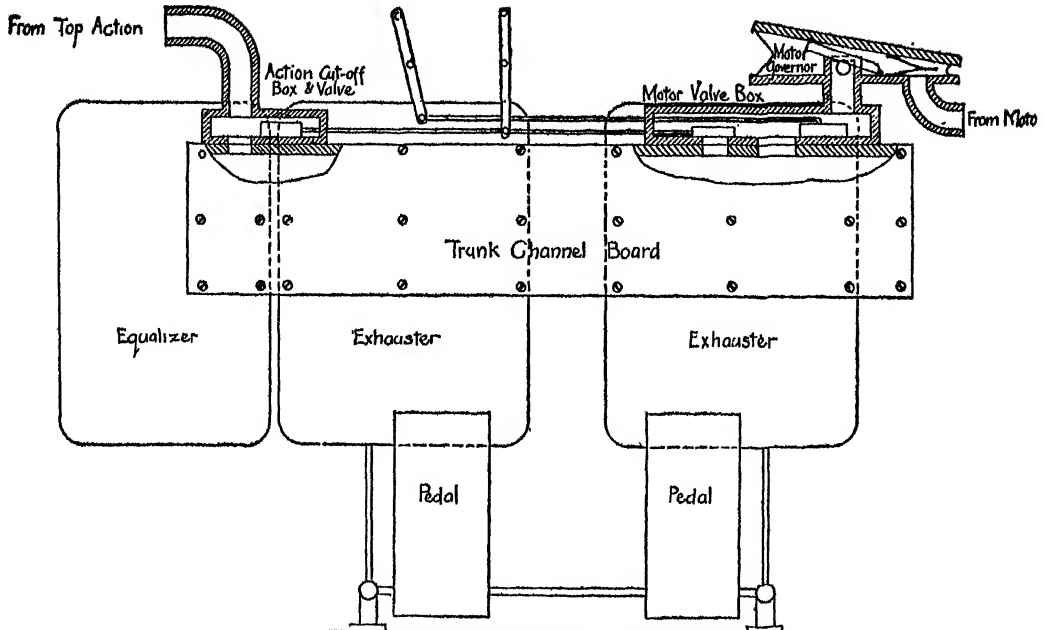

FIG. 3. DIRECT-VARIATION BELLOWS-SYSTEM

two exhausters, also the absence of the auxiliary exhauster for the playing action. It will be noted that the exhausters and equalizer in these drawings are placed in series, all giving on to a trunk-channel, which forms the common passageway of the system and leads to the playing action. Also it will be observed that the motor auxiliary equalizer is placed, in these drawings, away from and above the bellows-system. Actually this method of construction is often used, but in the present instance has been employed only for the purpose of making the operation of the auxiliary equalizer clearer to the student.

I shall have to speak of the auxiliary equalizers at greater length towards the end of this chapter. At present it is only necessary to observe that the action of this "governor" (as it is commonly called) is exactly the same as that of the large general equalizer. The difference is that the auxiliary device works only on the stream of air exhausted from the motor. Its object is merely to steady the motor under all conditions.

When we come fully to discuss the motor governor construction I shall explain the operation of the valve-box which regulates the motor speed through the medium of the tempo

lever. This box may be seen in the attached illustration immediately adjacent to the governor itself. In fact, the two devices are often built together, practically in an unit. The operation of the action-cut-off valve is also to be observed in these drawings. This is a very simple device, which consists of a valve sliding over the passage-way between the bellows-system and the playing action. By means of a rod connection, from a finger lever, this valve is slid over the passage when the re-wind lever is thrown into the re-wind position, thus cutting off the action, while the motor, the transmission gear having been shifted, is rolling the paper back on its spool. It may be noted here that the valve-box has also an auxiliary valve which will be explained later, the function whereof is to open the motor to the full strength of the bellows at the same time as the action-cut-off valve is thrown over. Both valves are operated by the same motion of the re-wind lever, which also shifts the transmission gear. Hence the motor re-winds with all the force of the bellows-system, while the action remains silent. If it were not for this re-wind valve, the music would play backwards while the roll was re-winding.

So much for the general make-up of the direct-

variation bellows-system. The indirect-variation system differs from it in details only, though these are important. They will be revealed by a glance at the illustration, (Fig. 4), which shows an indirect-variation system with its various elements. It will be observed that in addition to the usual arrangement of exhausters there are provided two equalizers and an "expression governor" or auxiliary equalizer operating upon the playing action. In some classes of bellows-systems of the indirect type there are two of these governors, each acting on one half of the playing action, which is divided into two compartments.

The student will be able to identify the details of the indirect-variation bellows-system by reference to the drawing. It will be seen that the general make-up differs principally in regard to the governor arrangement and the addition of an extra equalizer. There is however a point to be considered which we have as yet not discussed at all. The spring compression and expansion in the indirect system generally is greater than in the other. For instance, the two equalizers of the indirect system commonly use two 14 lb. springs apiece instead of one, while an extra wooden spring of 12 lbs. pressure is provided outside one

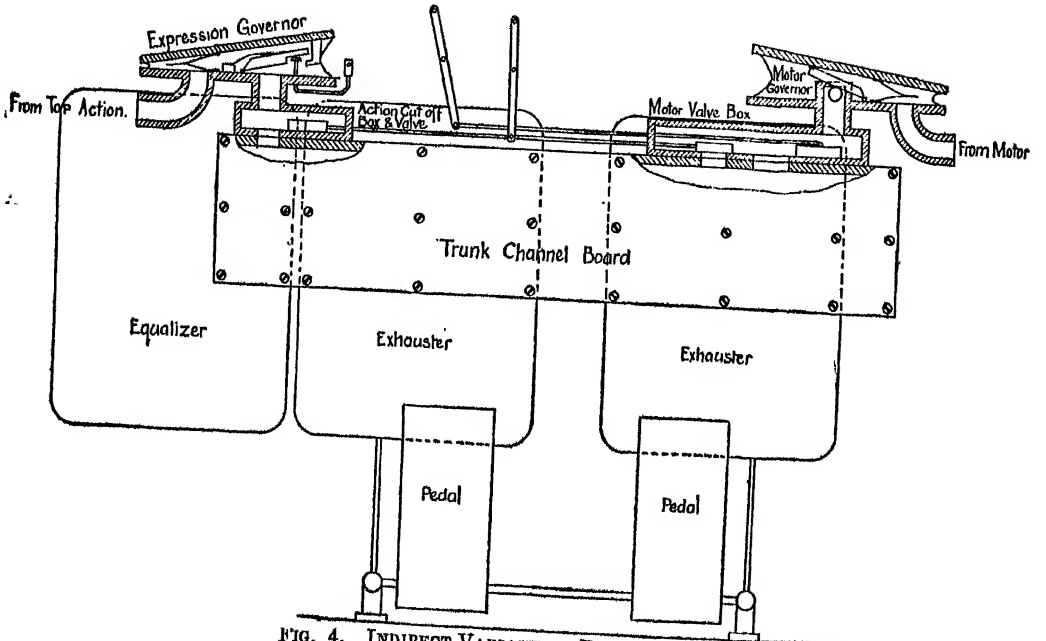

FIG. 4. INDIRECT-VARIATION BELLOWS-SYSTEM

of them. This latter spring is so arranged that it does not come into contact with the equalizer until the latter is half closed. The object is to prevent the equalizer from closing entirely, which latter effect would destroy the value of the device for the time being. Naturally, with such an amount of extra spring expansion on the equalizers, the foot-pedal control is less rapid and easy. The advantage to be placed against this is the greater steadiness and reserve power of the bellows-system. The governor arrangements, which we shall describe below, are devised to substitute another method of accentuation for the direct control through the exhausters.

With the indirect-variation system, it is understood that the arrangements for accentuation are not dependent solely upon the direct action of the exhausters. Instead, there is added to the bellows-system an auxiliary equalizer, called an "expression governor," placed adjacent to and in communication with the channel which connects the bellows with the playing action. This auxiliary equalizer is small in size and expanded by a light spring. It forms part of the expression valve box, as will be seen by reference to the illustration (Fig. 4), which shows this valve with the

auxiliary equalizer in communication therewith. The reader will note that the action cut off valve is contained below and the expression valve above, there being a passage between the two. Also it will be seen that the auxiliary equalizer itself comprises the chamber in which the expression valve operates. The expression valve can be dropped down by means of a lever so that the expression governor will more nearly close. This cuts down the exhaust power and causes the pneumatics to collapse more gently. The auxiliary equalizer operates to prevent the exhaust power from being cut down too much when the exhausters are operated very gently and at the same time prevents the player-pianist from forcing the power too high against the partially closed valve when pedalling very energetically. The principle of operation whereby this is done is explained in the first chapter.

The drawing here shown of the indirect-variation system with its auxiliary equalizer also shows the equalizer used especially for motor. No further explanation is needed concerning the latter device, since enough has been said already about the expression equalizer, and the principle in both cases is the same. For further discussion

of various types of these devices and complete descriptions of their operation, the reader is referred to Chapter IV, Part 2. I have contented myself in this place with illustrating the general principles involved.

It will be observed that there are a number of minor variations in construction prevalent among manufacturers who adhere to either of the great systems here described. In Part 5 of this work, where I describe individual systems of player mechanism, some of these bellows-system variations have been noted. In general, however, the illustrations in this chapter reveal quite clearly the lines of construction adopted by the majority of manufacturers. I have been able to show the broad lines of direction, and the intelligent reader will ask no more of me at this point of our discussion.

One rather significant fact I ought to mention. It is that the developments of the last years or so indicate that the direct-variation type of bellows-system is becoming a recognized complement of the single-valve-system, while the indirect-variation bellows are almost always found in connection with the double valve control. The significance of the fact lies in its clear indication that

the player world is more and more definitely being divided into two schools; one which believes in the direct expression control of the foot on the pedals, and another which believes in additional devices, operated by hand or automatically, for accomplishing the niceties of expressive playing.

It is neither necessary nor appropriate to express any opinion in this book as to the relative excellence of either principle. In fact, I should be doing a much greater service to the industry by saying, as truthfully may be said, that there is room for both. The artistic type of person, who treats the player-piano as a real medium of interpretation, will prefer one sort of system. The ordinary layman, who simply wants easy music, will prefer the other. And there is no use whatever in exciting oneself as to which ought to be their choice.

. . . . . .

The materials which enter into the manufacture of bellows-systems require brief notice. A moment's thought will show that the strain which is placed upon the exhaust units when the internal air pressure is being rapidly reduced, must be very high, and it is plain that precautions must be taken to prevent the structure from being twisted

out of shape under such conditions. To this end, it is customary to build the exhaust units of quartered hard wood, using three or more laminations and cross-banding these. The trunk-channel boards also are usually built-up in like manner. It is also customary to build-up the moving walls of the equalizers.

Various materials for covering the exhaust and equalizer units have been tried and there is considerable variation in general practice. Rubber-impregnated cloth, stockinette and canvas cloths are variously used. Kid, sheepskin and other leathers are also employed to form packings between the panels of trunk channels and other parts of the system where there is any possibility of leakage.

Modern practice differs considerably in all the details of bellows-system construction, but the principles laid down in this chapter will be found to hold good invariably.

Chapter II.

THE PNEUMATIC ACTION.

I have already spoken of the operating principles on which the playing action of the piano-playing mechanism depends. In the description given of these principles in Part I, however, I spoke almost entirely of the single system; that wherein one valve is employed to control the pneumatic directly from the tracker-bar. Although the description there given is entirely correct, manufacturers have adopted various modifications in practice, which often considerably alter physical appearance and operating processes. It is necessary therefore to consider this phase of our subject with some care.

Just as bellows-systems may be divided into two classes, so a similar two-fold division may be made in the description and classification of pneumatic actions. In fact, the division is here more definite and positive, since it rests upon the difference between the use of one valve to each pneumatic and of two valves for the same purpose. There are, in

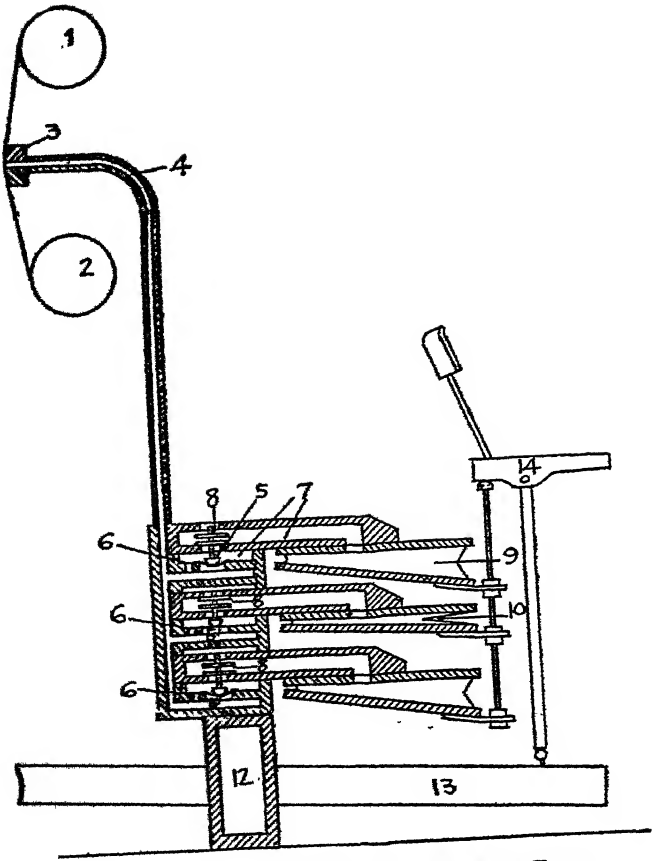

FIG. 5. PNEUMATIC ACTION; SINGLE VALVE TYPE

1. Music Roll.
2. Take-up Spool.
3. Tracker-Bar.
4. Tracker-Tube.
5. Pouch.
6. Vent.
7. Reduced Pressure Chamber.
8. Valve.
9. Pneumatic open.
10. Pneumatic closed.
12. Passage to Bellows-System.
13. Piano Key.
14. Piano Action.

wo pneumatics are abown open, and one closed. Valves are in corresponding positions

fact, two great divisions in modern practice which rest upon this one difference, and the best inventive thought seems to be almost equally divided between them. As I remarked before, the direct-variation bellows and the single-valve playing action seem to go together, while the converse is true of the other system. Although I do not wish to lay undue stress upon this fact, the reader will appreciate its significance.

The two systems of pneumatic and valve construction therefore may be termed respectively the single-valve and the double-valve systems. I propose here to give a succinct account of both.

By this time, I presume, the general operation of the playing action will be clear enough to the reader. It is only necessary for us to consider, as illustrated in the practice of manufacturers, the practical translation into mechanical fact of the principles already laid down. Let us begin with some consideration of the single-valve system.

The illustration (Fig. 5), shows, in due proportion and with especial attention to clarity, a sectional view of a single-valve action, indicating the tracker-bar, ducts, vent, valves and pneumatics. The reader should understand the operation of these without any trouble, but there are one or two

points that require some consideration. In the first place, it should be understood that the essential difference between this type of action and the double-valve system which is described later, is that in the present case the one valve is required to do all the work of controlling the pneumatic, directly from the tracker-bar. Now it is perfectly plain that since there are nine holes in the tracker-bar per lateral inch, the possible quantity of air that can get into them in any given period of time is not more than can get into the other action where a small primary valve is interposed between the original valve and the pneumatic. Thus it is necessary that the single valve be at once delicate enough to operate efficiently on the small quantity of air mentioned, and large enough to permit the immediate and efficient operation of the pneumatic. The single valve, in fact, must be larger than an ordinary primary, but not so large as an ordinary secondary valve. The pouch also must be larger than the pouch of the primary valve. Thus it is necessary that the pressure under the pouch be not too near in level to the pressure above. These are mechanical questions, and the designer is obliged to work them out for himself.

that the diameter of the pouch in the single-valve system should not exceed 1″ and the diameter of the button which rests on it not more than ⅞″. The disks of the valve likewise should have a diameter not greater than 1″.

The modus operandi of the single-valve system is not at all complex. When the tracker-duct is covered at its outer end by the paper, and the bellows are operated, the air pressure within the reduced-pressure chamber is of course brought down below normal. At the same time, by means of the very small hole (1/64″ diameter) in the vent, the pressure is also reduced in the chamber under the valve pouch and in the tracker-duct itself, although not to so great an extent. Naturally, therefore, the air-pressure external to the top disk of the valve will keep the latter firmly down on its seat, shutting off the pneumatic from the reduced-pressure chamber and keeping it in communication with the atmosphere. The pneumatic therefore will remain open. But when the tracker-duct is opened, through a hole in the paper registering with it, the atmosphere rushes into the duct, since its pressure is higher than that of the contained air therein, and forces up the pouch. The valve rises against the external pressure, because the

area of the pouch is greater than that of the top-disk. Hence the passage between the pneumatic and the atmosphere is shut off, while the passage between pneumatic and reduced-pressure chamber is opened. Hence the pneumatic is put in communication with the reduced-pressure chamber, and its contained air, being at higher pressure, rushes out into the former, where it is dissipated and finally sucked out through the bellows. The reduced-pressure chamber must always bear such relations of area to the pneumatic that no number of the latter operating at once can suffice to throw into the former enough atmospheric air to restore the pressure, even for a moment, to normal.

When the tracker-duct is again closed by action of the paper, the contained air within the former and under the pouch is reduced once more through the small vent. Hence the external pressure on the top disk of the valve pushes the latter back on to its seat. The pneumatic is once more put in communication with the atmosphere while being shut off from the reduced-pressure chamber, and therefore again closes.

It is to be observed that the single-valve system is not limited by the sort of construction which I

have illustrated. There are a number of systems, such as those of Melville Clark and M. Schulz, where the valve is in the form of a small bellows. The Schulz system is especially interesting in this regard, as may be observed by reference to the descriptions in the latter part of this book. Another very interesting and efficient system is that of Gulbransen, wherein the pneumatic and valve are built together in an unit. This method is explained in full in the descriptions of individual systems.

It would be neither appropriate nor very useful to devote space here to a consideration of the relative advantages possessed by the two great valve systems. Let it be said that either can be equally efficient, and that either also can be equally inefficient. It is solely a question of refined workmanship and careful design. The single-valve system must, doubtless, be more perfect than the other; but a good many manufacturers have discovered the secret of uniting single-valve simplicity with efficient construction. All in all, it would be better if everybody could arrange their mechanisms so as to obtain the same result. So long, however, as this is not so, we must be content to

remember that a player mechanism can be perfectly efficient whether it has the single- or the double-valve system.

The sole difference between the single and the double systems lies in the interposition of a primary valve between the tracker-ducts and the valve which controls the pneumatic. This latter is called the secondary valve in these systems. In the illustration which is attached to this description, I have shown the general lay-out of such a system. The reader should use this illustration in order intelligently to understand what follows.

When the music-roll completely covers any tracker-duct, the air in the duct is reduced in pressure as soon as the bellows are operated. The vent is situated adjacent to the primary valve, which is forced upwards as described above. The top disk of the primary, as will be seen by reference to the drawing, is pressed tightly down upon the top board of the primary system by the external atmosphere and thus shuts out the atmosphere from the channel below it. When the action of the air rushing down the tracker-duct forces upward this primary valve, atmospheric air is admitted into the channel leading to the secondary pouch. This pouch forms the floor of the second-

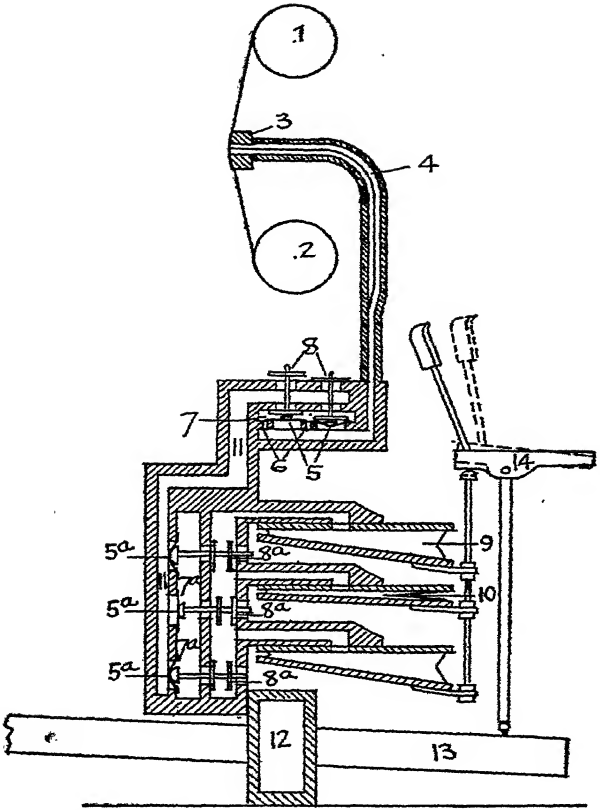

FIG. 6. PNEUMATIC ACTION; DOUBLE VALVE TYPE

1. Music Roll.
2. Take-up Spool.
3. Tracker-Bar.
4. Tracker-Tube.
5. Primary Pouch.
5a. Secondary Pouch.
6. Vent.
7. Primary Reduced Pressure Chamber.
7a. Secondary Reduced Pressure Chamber.
8. Primary Valve.
8a. Secondary Valve.
9. Pneumatic open.
10. Pneumatic closed.
11. Primary-Secondary Channel.
12. Passage to Bellows-System.
13. Piano Key.
14. Piano Action.

Two pneumatics are shown open, and one closed. Valves are in corresponding positions

ary reduced-pressure chamber, in which is the secondary valve. It will be observed that the channel leading to the secondary pouch is kept at reduced pressure when in normal condition through the fact that it leads from the primary and is thus affected by the vent. The secondary valve, therefore, is kept firmly on its seat in normal condition through the external atmospheric pressure on its outer disk. When the atmospheric air reaches the secondary pouch the secondary valve acts just as does the single-valve system. The reverse of the operation is also the same exactly.

It is customary to enclose all the primary valves within one chamber immediately under the tracker-box, and then to place the secondary valves in another chamber under the primaries. In some systems the secondaries are disposed vertically, in others laterally. The former position is theoretically superior, since the recovery of the valves is assisted by gravity when they are placed upstanding. The pouches, both of primary and secondary systems, are usually assembled on one board, which may be unscrewed and removed. The channels between the primary and secondary valves run through the boards of which the cham-

bers are built. All this may be seen by reference to the illustrations.

It will be understood that there are many possible variations on the double-valve arrangement here illustrated. The latter is perhaps the simplest, but many possible differences in constructional detail are permissible. For instance the pneumatic and secondary valve, in the Cecilian mechanism, are built as an unit, with the primary adjacent to it. In the Behning mechanism, the primary chamber is placed immediately in front of the secondaries. And many other variations are in use. But the student need not be alarmed at this. He will find that the descriptions here given will provide him with information quite sufficient to enable him to recognize all the parts of any mechanism.

As for materials, it is customary to use quartered lumber for building the valve chambers and the practice is increasing of employing a built-up laminated construction, to the end that warping and twisting may be avoided. The Cecilian mechanism is built of metal, and recent inventors have given much thought to a combined wood and metal construction, whereby the parts of the valve chambers in which the pouches rest are built of sheet-

metal, also to avoid the bad effects of twisting and warping. Kid and sheepskin are commonly used for pouches, with some form of rubber impregnated cloth for pneumatic coverings. The spindles of the secondary valves are generally of light wire with leather disks. Sometimes fibre covered with leather is used. Primary valves are usually built of wood, with wooden disks, covered on one side with leather. Buckskin makes an excellent packing for joints which must be air-tight. It is now almost universal practice to provide the secondary valves with metal seat-rings, to the end that they may rest closely in their places and reduce leakage to a minimum.

Experience also shows the usefulness of shellac as a preventive of leaking. All good practice demands that the walls of the chambers, the channels, and the valve passages be well shellacked. Shellac is an excellent material for stopping small leaks in a wooden board.

The tracker-box is an important part of the player mechanism which requires careful illustration and study. It consists, as is well known, of a frame which supports the tracker-bar, in which are assembled the ducts leading to the primary pouches, a take-up spool, music-roll chucks,

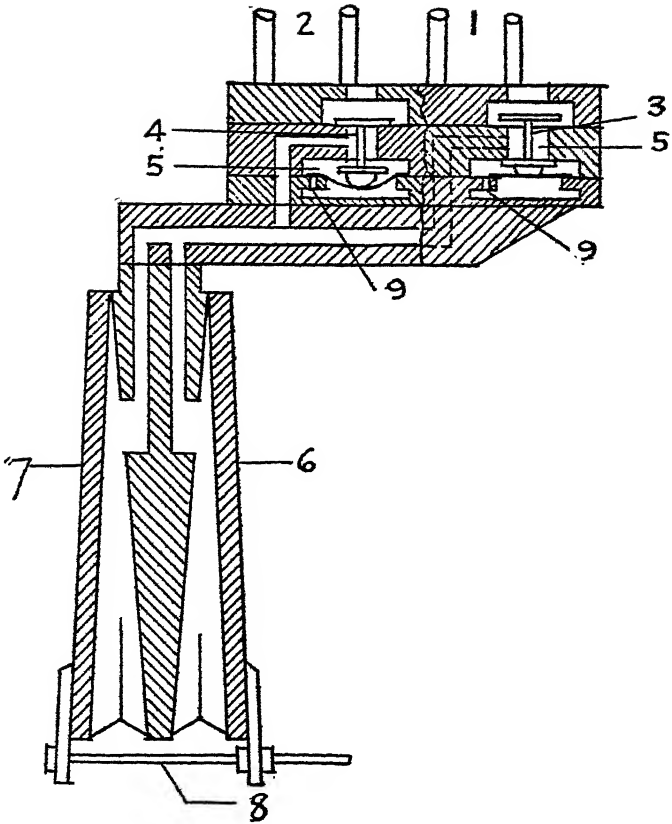

FIG. 7. AUTOMATIC TRACKING DEVICE

1. Tubes from right hand marginal ducts in tracker-bar.
2. Tubes from left hand marginal ducts in tracker-bar.
3. Right hand controlling valve.
4. Left hand controlling valve.
5. Right and left hand reduced pressure chambers.
6. Right hand pneumatic.
7. Left hand pneumatic.
8. Connecting rod to shifting mechanism.
9. Vents.

and usually some form of tracking-device, whereby the paper roll may be kept at all times in true register with the holes in the bar.

The tracker-bar to-day is preferably made of solid brass, drilled for the ducts, which terminate in brass unions, upon which are secured the tubes to the pouches. These tubes may be of rubber or metal and opinion is divided as to the relative advantages of either material. The take-up spool may be of wood or metal, and is lightly balanced in metal bearings.

The automatic tracking device, illustrated here, may be of different types. I show one type only, choosing it for its simplicity. For controlling this there are extra perforations at the right and left ends of the tracker-bar. Normally the music-roll covers these. If, however, the paper sags to one side or the other, one of the holes will be uncovered. When this happens, valves are operated and a pneumatic is collapsed, which by its movement in collapsing shifts one of the chucks so that the roll is automatically brought into line again. The illustration shows the principle very simply. Other similar devices operate by flanges against which the paper bears, which by their lateral movement open holes and operate valves.

Chapter III.

THE MOTOR.

The music-roll which controls the operation of the player mechanism must travel across the tracker-bar, in order that its perforations may register in order of succession dictated by the nature of the music. Hence there must exist some form of motor to wind the roll over the tracker-bar, and to re-wind it upon its spool when the music is finished. Various forms of motors have been used, but modern practice has almost universally chosen the pneumatic machine, and of this I shall principally speak in this chapter.

The governing principle of the pneumatic motor is exactly the same as that of the playing mechanism itself. The power is produced by the action of the bellows-system and the motor performs its work through pneumatics of a type not dissimilar from those which are used for the actual operation of the piano action. Briefly, the pneumatic motor may be described as a series of pneumatics, placed side by side, and mounted on a trunk-board.

Through a system of slide-valves, these pneumatics are caused alternately to open and close, and the resulting motions of their moving walls are translated into a rotary motion through a crank-shaft and connecting rods.

The illustration will show the principle very clearly. Three, four, five or six pneumatics (according to the individual design) are assembled side by side, with their fixed walls mounted on a trunk-board through which runs a passage way communicating with the suction tube to the bellows. To the moving wall of each pneumatic is attached a connecting rod, and all the latter are assembled on a crank-shaft at equal angular distances around it. The passage way through the trunk-board to the bellows is pierced with ports extending to the outside of the former, opposite each pneumatic. Above or below these ports are bored others, not touching the suction passage but running straight back into the interior of each pneumatic. Thus there are two ports opposite each pneumatic upon the trunk-board surface, exactly above and in line with each other. Over these ports slide valves, whose motion is determined by the crank-shaft, to which they are attached. These valves are in the form of hollow

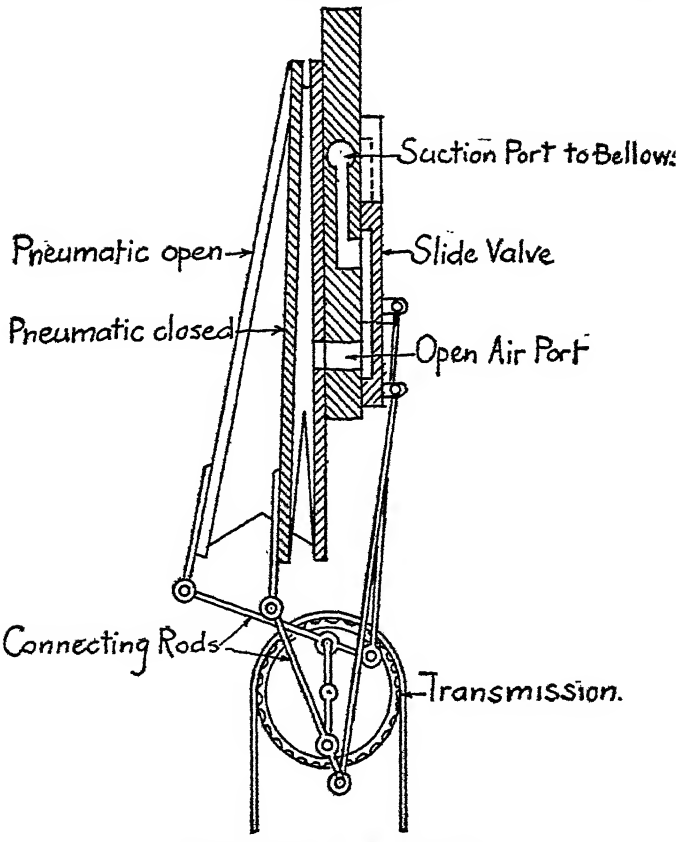

FIG. 8. THE PNEUMATIC MOTOR

blocks. When a valve is in such a position that it covers both ports, the air pressure in the interior of the pneumatic is reduced and the pneumatic

closes. When at the opposite end of its stroke, the open-air port is exposed while the suction port is covered. The valve, in fact, alternately connects the two ports and exposes the open-air port. The suction port is, of course, never exposed to the open air. The external pressure of air upon the surface of each valve keeps it firmly on its seat, and communication between the two ports is made possible by the hollowing out of the valve. Each pneumatic therefore alternately opens and closes, the controlling slide-valves moving as the crank-shaft turns, and the latter moving in obedience to the motion of the pneumatics transmitted through the crank-shaft. A glance at the illustration will be sufficient to disclose the principle clearly.

It should be noted that many variations from the simple type here illustrated are to be found in the practice of different manufacturers. For instance, some systems employ one valve for each pair of pneumatics. This is when there are four or six of the latter. In this case the suction port is placed in the middle, with two open air ports, one for each pneumatic, above and below it. Thus the one valve, in the same manner as before, may control the action of two pneumatics.

A further variation is seen in the pneumatic

motors of the Aeolian Co., and in some others. Here the pneumatics are doubled, one being superposed on another, with a joint between the two. In fact, in this style of construction each unit becomes a double pneumatic. The valve control is the same as in the last case; two open-air ports and one suction port assembled together.

It is necessary for the purposes of playing to control the speed of the motor from time to time, and it is also necessary that this control be at the pleasure of the player-pianist. Hence it is necessary to provide a controlling valve, which can be operated by the player-pianist at will. It is also necessary to have an arrangement whereby the motor can re-wind the music-roll.

In figures 3 and 4, pages 31 and 35, are shown the outlines of a motor-governing valve and rewind. It will be observed that the former consists of a box communicating with the suction tube between motor and bellows, and forming part of the way through which the air from the motor must travel. By means of a sliding valve, operated by a finger lever, the passage may be more or less opened or closed. The speed of the motor depends therefore, at any given time, upon the position of the valve with relation to the slot in the

suction passage. For a detailed drawing and description of this, the reader is referred to figure 10, Chapter IV, Part 2 and to the description therein contained. The same description explains the auxiliary equalizer attached to the motor valve-box and the re-wind and action cut-off, which likewise are concerned in the work of the motor.

When we throw over the re-wind lever, we at one and the same time perform three separate actions; viz: (1) we cut off the playing action from the bellows (2) we open a large port in the motor valve-box, and (3) we shift the transmission gear so that the motor operates on the chucks instead of on the take-up spool. In this manner the motor is given all the power of the bellows and the roll is wound backwards. In order that the third action of the re-wind lever may be well understood, the reader will note that when the re-wind lever is moved, one of the levers which move with it changes the gearing from the take-up spool to the chucks. Also it will be noted that the same re-wind lever, by means of other connections, as explained in Chapter IV, Part 2, operates the action-cut-off and the re-wind power valve in the motor valve-box.

There are variations on the simple mechanical

form of transmission gear. In some cases the re-wind gear-shift is performed by a pneumatic which is exhausted by being brought in communication with the bellows through the action of the re-wind lever. But the direct mechanical gear-shift is usual, although there are numerous slight variations in form.

Of motor types which differ largely from what has been described above, while retaining the pneumatic principle, the most interesting perhaps is that of Gulbransen. In this type, the pneumatics are replaced by metal cylinders, which contain pistons sliding up and down in the manner of a steam engine. Connecting rods, crank shaft and other details complete this resemblance. Each cylinder is double acting, having ports above and below the piston with rotating reciprocal valves assembled behind and below the cylinders. This is a powerful and economical motor, which however requires rather more care (in oiling, for instance) than the others here described.

The materials employed in the construction of motors are wood, metal, leather, and rubber-impregnated cloth. The pneumatics and trunk are usually of wood. The valves are also generally wooden but often the seats on which they slide are

metallic. Sometimes the whole valve is made of aluminum, or of some similar metal. Crank-shafts are of light metal and connecting rods either of wood or wire. Packing and pneumatic covering follow general practice.

During the earlier days of the industry, there was much discussion as to the merits of the mechanical as against the pneumatic motor. The issue however has determined in favor of the former, although one great manufacturer (Melville Clark) still uses the mechanical motor. Essentially this is a piece of ingenious clockwork, kept wound by the action of the foot-pedals, and kept from over-winding through the action of a friction clutch which slips when the spring tension becomes powerful enough. A centrifugal governor keeps the movement steady and a light brake regulates it. The advantages of the spring motor are obvious enough. Speed is constant, the bellows are relieved from the burden of furnishing power for the motor, and the whole series of governors, motor valve boxes, action-cut-offs, etc., are done away with. Moreover, the player-pianist is relieved from the labor of pedaling to furnish power for the re-wind, as the spring is always large and powerful enough for this purpose. Yet, the pneu-

matic motor is probably quicker in response to the valve than the spring machine to its brake; and this is no small advantage. Spring motors have remained a feature of practice in the one large house mentioned but elsewhere seem to have been generally abandoned.

The requirements of a perfect pneumatic motor are (1) ability to operate steadily under all fluctuations of bellows-power, (2) lightness and small power consumption, (3) immediate response to any change of tempo lever, (4) sufficient energy to turn any weight of roll at the required speed. Naturally, in determining the dimensions of a motor, the actual requirements of the work must first of all be considered. When it is considered that, within the ordinary dimensions of motor pneumatics, it would be possible, under energetic pedaling, to produce active pressures of no more than 50 ounces over the entire surface of each unit, it will be seen that the margin of power is not very great, and that the motor must be carefully designed in order to perform its work exactly. On the other hand it is to be observed that the motor must not have an excess of power, for then it will be too heavy. If it were not for the lightness of the motor's work and for the fact that the

player-pianist is too much occupied with the aesthetic result of his pedaling to bother about any other effect attributable to bellows action, it is probable that more attention would be paid to the economy of pneumatic motors. As things are, however, it is not necessary that theoretical economy, or even an approach to it, should be attained. Convenience, lightness, and responsiveness are the only essential features, and these are well achieved in existing designs.

Chapter IV.

THE MECHANISM OF CONTROL.

The governing and controlling devices which form so necessary a part of the player mechanism, may be classified under the heads of: (1) Tempo control and government, (2) Re-wind control, (3) Expression control and government. I shall consider them therefore in this order.

Tempo control and government involve two different conceptions. In the first place the motor must be under the control of the player-pianist. In the second place it must be automatically governed so that whatever speed is desired at a given moment may be steadily maintained, until deliberately altered, without being affected by changes in the intensity of pedaling. The two requirements naturally run together, and the device which accomplishes the one purpose is nearly always in intimate connection with that which achieves the other.

In illustrating the two complementary devices, therefore, I place them together as will be seen in

fig. 9. Here we see the motor valve box with its auxiliary equalizer attached to it. The suction from motor to bellows proceeds through this box. It will be observed that the box contains two ports which can be covered by sliding valves, and also two passages communicating with the motor and the bellows system respectively. The motor valve box is usually placed in immediate contact with the upper surface of the bellows-system on the side nearest the motor; that is to say, on the treble side of the piano immediately beneath the key-bed. The illustration shows the front cover of the box removed.

The slot in the box which looks like the outline of a rather skinny wine-glass with a long stem is the tempo slot. When the valve is drawn over it the size of the orifice is changed from moment to moment and the speed of the motor is thus regulated. While this is happening, of course, the re-roll motor duct, which is the round orifice in the box, must be closed. In point of fact, the same motion of the re-wind lever on the key-slip which opens the action cut-off valve in the action cut-off box at the other end of the bellows-system (see figs. 3 and 4) and throws the take-up spool in gear with the motor

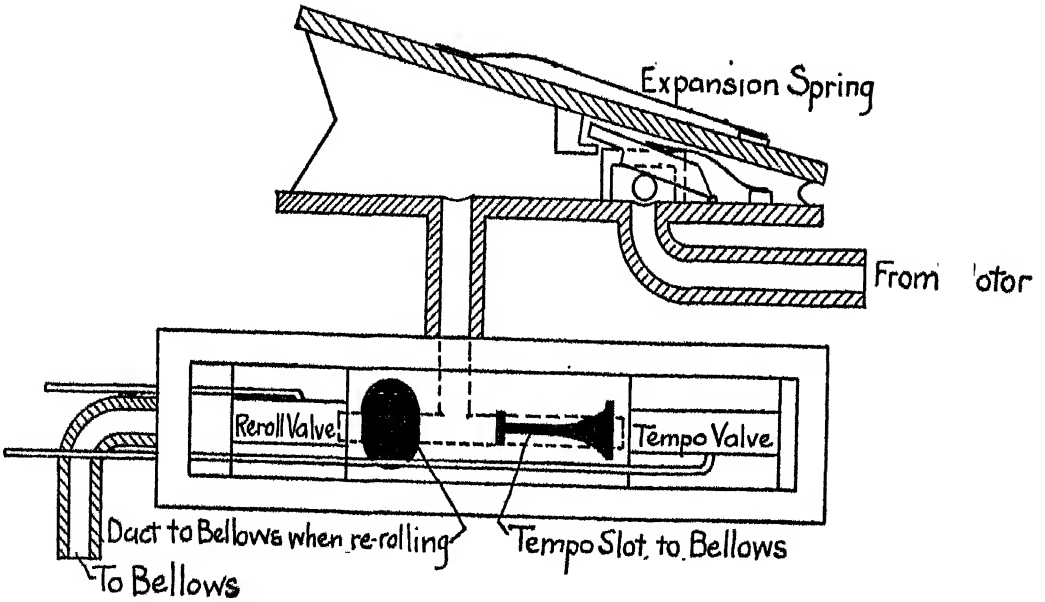

FIG. 9. MOTOR VALVE BOX WITH AUXILIARY EQUALIZER

(thus making playing possible), also closes this re-roll motor duct in the motor valve box. Thus, when the player mechanism is in use, the motor is under the control only of the tempo regulating valve, which in turn is manipulated by the tempo lever on the key-slip. The illustration shows this clearly.

The re-roll motor valve and duct come into use when the motor is rewinding. Then, by the same action of the rewind lever, the action is cut off, the transmission gear shifted and the motor re-wind duct opened, so that the full power of the bellows may operate the motor at full speed, insuring a rapid re-winding.

The motor governor, as we have already stated, is an auxiliary equalizer, of which the functions are precisely the same as with the large equalizing bellows, with the difference that the former work only on the motor. In the illustration I have shown the governor immediately in contact with the motor valve-box. Very often, however, the governor is placed away from the valve box, with a passage leading from one to the other. All that is necessary is that the main pressure-reducing passage should lead from motor to governor, from governor to valve-box and from valve-box to bel-

lows, without any other communication between any of the parts. All are therefore interdependent.

The object of the motor governor is to maintain the speed of the motor according to whatever the position of the valve on the tempo regulator may be, so that no change in the force of pedaling can work a corresponding change in the motor speed. For instance, if the tempo lever is placed in the half way position and the valve therefore covers a corresponding portion of its port, the speed of the motor will be such that it moves 6.5 feet of paper over the tracker-bar per minute. Now it is plain that if the player-pianist suddenly begins to pedal much more energetically than was the case when the speed reading was taken, the speed will increase. The reason for this is that, while the tempo valve remains in the same position, the increased rapidity of bellows action produces a greater speed of pressure reduction throughout the whole player mechanism, so that the motor must be affected even though the port remains partially covered. The precise reverse of this of course will occur when the given speed of pedaling is suddenly cut down. Hence, when it is considered that the foot work on the pedals

must be constantly shifting, in accordance with the demands of artistic playing, it is plain that the motor speed can never be kept constant for any given position of the tempo valve, without some form of automatic regulation.

The reader will at once see that the equalizer expresses perfectly the regulative principle required. The main equalizer performs for the exhausters just such a service of regulation as this. Hence it is only logical to apply the equalizer principle to the government of motor speeds.

Reference to the illustration (fig. 9), will show how this is done. The auxiliary equalizer or governor is naturally affected by the operation of the bellows-system, and its movable wall therefore is in a state of continual back-and-forth motion. If the pedaling be energetic the moving wall of the equalizer is drawn in and in the course of this motion shuts off more and more the passage way from bellows to motor, as will be seen from the illustration. Contrariwise, if the pedaling be decreased in rapidity, the equalizer will open, and the passage way will be enlarged. This enlargement of the passage way will occur only when the force of pedaling is decreased. When the reverse occurs it will in turn be made smaller. Thus the

size of the passage way must necessarily govern and control the power given to the motor, since the very act of operating the bellows with the feet sets the governor in automatic motion. Thus the speed of the motor will be kept steady, provided only that the governor be properly adjusted so that it will open and close to the right extent. This is determined by experiment. These governors are generally provided with regulating screws, whereby the extreme position of closing can be altered at will, and also with another screw for regulating the tension of the expansion spring which is so necessary a part of the device.

Various differences in detail exist in the construction of these devices, but the principle here illustrated is found in easily recognizable form throughout them all.

The re-wind action cut-off is illustrated quite clearly in figures 3 and 4 of Chapter I, Part 2, and needs no further comment.

There are a number of additional devices concerned with the control of speed which I must describe here. Foremost among these in point of age and interest is the famous "phrasing lever," invented by the Wilcox & White Co., and used by them in the well known Angelus player mechan-

ism. This consists of a lever, manipulated by a tilting finger-tablet, and connected with the motor governor in such a way as to allow the player-pianist to open or close the governor at will. When the governor is closed the motor at once stops, as its suction way is cut off. When the governor is opened to full width the motor is running at full speed. Between these two extremes a multitude of fine speed shadings is possible, and the special advantage is gained of extraordinarily quick stops, starts and speed changes, all of which add materially to the artistic possibilities of playing.

Another device often met with is the so-called "skip." This simply means that an extra door is placed in the action cut-off box so that, when a button or lever is pressed the door is closed and the action cut off without the transmission gear or motor valve-box being affected. This may be done by a direct lever action or through a button opening a duct and raising a pouch and valve, thus operating a pneumatic to close the door. When this is done the motor will drive ahead with the action cut off, thus enabling the player-pianist to skip any portion of a roll that he may not wish to play. A similar device is the motor stop, which

consists of the same idea applied to the motor-valve box, whereby the whole passageway to the motor may be shut off, thus permitting a sudden stop.

The "metrostyle" is a mechanical pointer guide on the tempo lever in connection with a curving line running from beginning to end of a roll, for the purpose of guiding the amateur in tempo-lever manipulation, and is an exclusive feature of the Pianola mechanism.

The general topic of expression regulation and government is of intense interest and importance to the student of player mechanism. Not only so, but it is one of considerable complexity. The views of inventors and constructors upon the general idea of musical expression, as represented in the player-piano, have differed so much that there are many different expression devices on the market in connection with one or another player mechanism. Nevertheless, when we undertake to analyze them we find it possible to put them all in comparatively few classifications.

The first and most important division under which we may classify the different kinds of expressive devices is the dynamic. That includes all devices which have to do with controlling the

force of playing, the intensity of blow upon the piano action; in other words, the loudness or softness. The simplest method, of course, in dealing with this question is to use the direct-variation bellows and let the control of dynamics be directly through foot pressure on their pedals. Even so, however, it is necessary for the purposes of practical playing that there should be some means of providing that one part of the music may be played more or less loudly than another. When the direct variation bellows are used for expressive dynamics, therefore, it is customary to divide the hammer-rail into two or three divisions and arrange pneumatic devices whereby any or all of the rail segments may be thrown nearer to the strings, just as the whole line of hammers is thrown forward through the operation of the ordinary so-called "soft-pedal" of the piano action. Such devices are operated by pneumatics, controlled by valves of the ordinary type, enclosed in small reduced-pressure chambers above the hammer-rail, with tubes for suction and open air respectively running from them to the bellows and to the controlling buttons. These buttons are placed under the fingers of the left hand, and when depressed

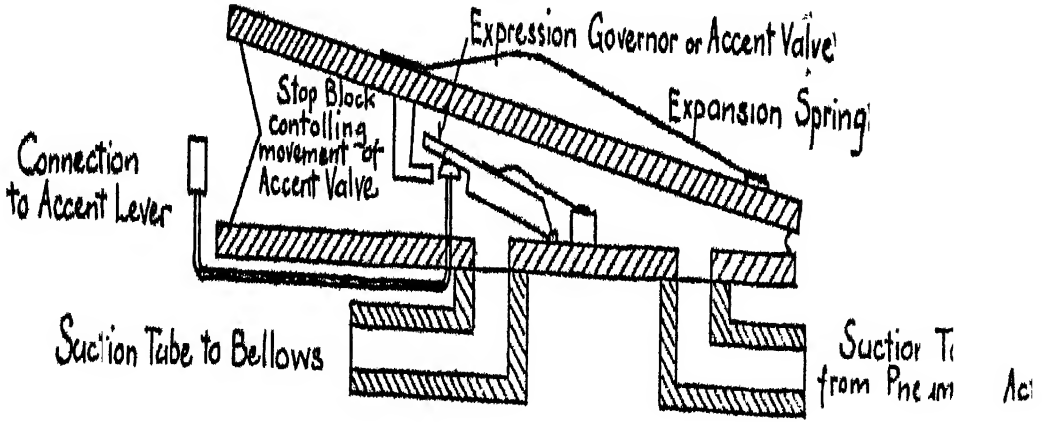

FIG. 10. ACCENT CONTROL WITH AUXILIARY EQUALIZER

open the ends of the tubes or ducts, admitting air into them as in the regular playing action.

The indirect-variation bellows-system, pre-supposes, of course, the existence of a special device for accentuation. The general theory of such devices is to provide a governor, like that which is used for the motor, whereby the pressure reduction in the pneumatic action can be decreased until the pneumatics collapse slowly and gently, thus producing a soft blow on the piano action; and to do this in such a way that no change in the force of pedaling can affect it. Then, if the situation be suddenly reversed, and the governor cut out of action, the result will be that the pressure reduction in the pneumatic action will instantly increase, and the next following note will be sounded louder.

In the illustration (fig. 10) I show the outline of such a device. It will be observed that the air in passing from the pneumatic action passes through a port into an auxiliary equalizer or governor, and thence out to the bellows through another port. In passing through the latter port, however, the air must flow underneath a hinged valve, which is held in position by means of a button on a threaded wire. This wire can be pulled down by means of

a thumb lever on the key-slip, and when this happens the hinged valve drops nearer to the port until checked by a stop attached to the moving wall. When in this lower position, the hinged valve positively shuts down the pressure reduction, and if the player-pianist pedals hard, the only result will be that the moving wall of the auxiliary equalizer will be drawn down so that the hinged valve will sink lower, as it is pressed by a spring and always tends to rest on the stop unless held away from it. Thus, when the accenting lever is held over in its "on" position, the player mechanism can only play very softly, no matter how hard the pedaling may be. In fact, if the pedaling be too hard the moving wall will be drawn down so close as almost to choke off the power entirely. When, however, the player-pianist lets go the accent lever, the latter, urged by a spring, swings back and pushes up the button on the threaded wire, thus opening the hinged valve and giving full power again. If the player-pianist then closes the accent lever when approaching the note to be accented and opens it again on its incidence with the tracker, closing again as soon as the note has passed over, he will obtain a series of accents exactly as required. In the illustration I

have followed the method of the Auto-Pneumatic mechanism, although the details are somewhat different.

The principle here involved must be carried out in one form or another in every device which is intended for the purpose above set forth. Whatsoever differences in construction are found to exist therefore will all obey the same laws and be based upon similar designs.

Some player mechanisms use two of these accent governors. The action is divided in two halves by a partition and one governor acts on each half. In this case two accent levers or buttons are used and the hammer-rail-lifter is generally dispensed with altogether.

The button method of accenting does not differ in principle from the direct lever system explained above. Exactly the same result is aimed at, but the regulating valve in the governor is closed by the action of air, lifting a pouch and valve. The reader will at once understand any such system by examining it.

Inventive ingenuity, however, has not been satisfied with even the highly efficient devices explained above. There has come about a desire to render tolerable playing even easier, especially

in regard to the dynamics of expression. It has been felt, in fact, that the layman is usually too indolent or careless to acquire that complete command over the resources of his player-piano which is necessary to the work of good playing. Hence there have been produced various devices, of which the object is to attain automatically, through the agency of the roll, such accentuation as is called for from time to time in a piece of music.

There are several of these arrangements. The theory of them may be considered in two ways, or rather it may be said that there are two theories in regard to them. One of these is distinguished for a directness and simplicity highly admirable. It is well represented by the well-known Solo-Apollo of Melville Clark and consists simply of using a separate pneumatic action for the notes which are to be accented. The accent action plays on high tension and the accompaniment action on low tension. Special rolls and a special tracker are necessary of course. The effects of such an arrangement are naturally very remarkable. Almost anything can be done in the way of separating various parts of composition. Accompaniments may be cut out and melodies alone played,

or the reverse may be accomplished with equal ease. The double action is of course rather bulky, but the results justify the necessary enlargements.

The other theory rests upon a peculiar modification of the accenting governor box which I described above. It is in reality a compromise with existing facts, but a very ingenious and effective compromise nevertheless. The basic idea is that if notes which are to be accented are slightly thrown out of line on the roll, then by means of a valve working automatically, the governor box may be manipulated so as to give the benefit of high tension to the selected note and low tension to the surrounding notes which form the accompaniment. In order, however, that the accented note should be produced so nearly simultaneously with the accompaniment as to conceal any evidence that it has been purposely advanced, the apparatus must operate very quickly indeed. In point of fact its operation must be completed in a small fraction of a second. The way in which all this is done is explained as follows:

The illustration (fig. 11) very clearly explains the theory of the automatic accenting device of this type. The illustration itself bears some resemblance to the so-called "Melodant" of the An-

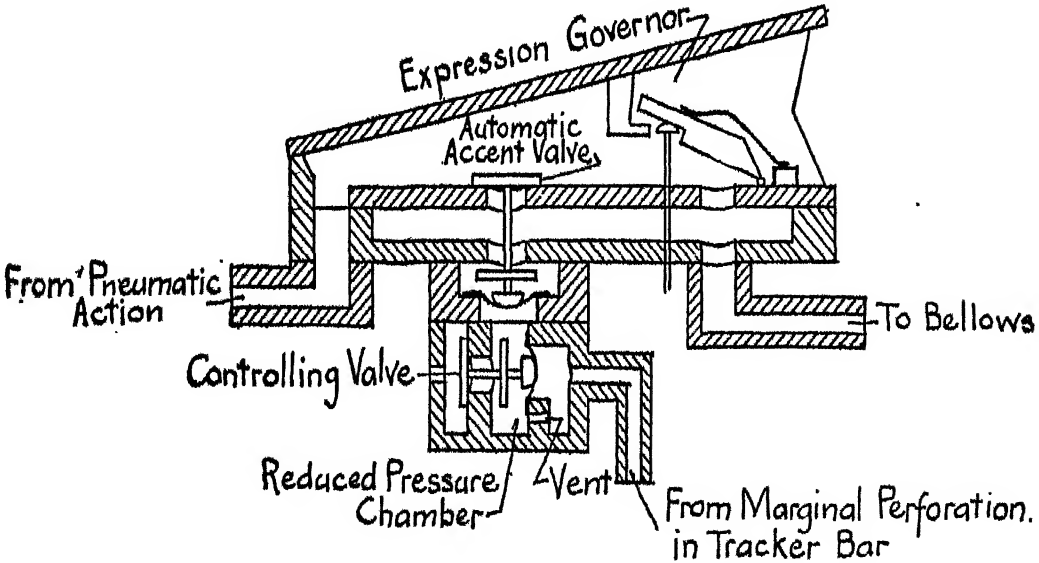

FIG. 11. THEORETICAL ILLUSTRATION OF AUTOMATIC ACCENT DEVICE

gelus mechanism, and is so used because thereby a very clear and simple drawing may be made. The "Themodist," characteristic of the Pianola, is based upon a similar method of construction, with some differences in detail, which however will be perfectly clear to any reader who will examine it in the light of the present explanation and illustration.

Here, then, is disclosed an expression governing box of the same general type as we have already discussed. The reader will note that the ordinary valve operable by button or lever is in place and also the auxiliary equalizer whereby the passage to the bellows can be gradually cut down in size as the pedaling becomes extra hard, provided that the ordinary accent valve is in its "on" position. Now, when the automatic valve is to be used, a lever on the key-slip or elsewhere is thrown, which permanently sets the accent device in the "on" position, with the hinged accent valve dropped down (see figure 11) so that the regulating governor or auxiliary equalizer is able to operate and to maintain a low tension under all conditions of pedaling. Suppose now that a certain note in a chord is slightly advanced out of its position on the paper roll so that it will sound a small

fraction of a second earlier than the other accompanying notes. Suppose also that there is a small marginal perforation in the paper exactly and precisely in line with the very beginning of that note. Suppose also that this perforation corresponds with a duct in the tracker leading to the valves which are seen in the drawing in connection with the automatic accent valve. Then, when the hole and the duct coincide, the valves will be operated and the automatic valve thrown forward. At once the air will be drawn through the new passage way so opened. The governor cannot close entirely because the stop on the moving wall forbids this. Thus the air passage is for the moment rendered much larger than it is when the accent valve is in the "on" position. Hence, for the time the automatic valve remains open, the tension is high and the piano plays loudly. Inasmuch as the perforation is made as small as possible, however, the action is almost instantaneous, and the slightly advanced note gets the benefit of accentuation without any hiatus being perceptible.

It is usual, of course, to divide the pneumatic action in two halves and have two accenting devices, one in each expression governor box. In this way the effect of a double accent can often be

iad; that is of an accent in the bass and of another n the treble simultaneously.

It is not only in this precise manner that the iutomatic accenter can be designed. For exam-)le, there might be provided a chamber at the side)f the governor, but opening into it, and the auto-natic valve might be arranged to open a direct)assage out of the chamber to the bellows. This would have the same effect. The principle is of :ourse identical in both cases.

The remaining expression device is that which is used to operate the sustaining or damper pedal)f the piano. Generally this is a direct finger or thumb lever (preferably the latter) connected with the damper lifting rod of the piano action. Sometimes a large pneumatic operated by the usual primary and secondary valve, or by two primaries, is used, under control of a button which closes or opens a duct. Or, in exactly the same way, the sustaining pedal may work automatically, simply by running a tube from the pneumatic box to the margin of the tracker, which will register with suitable perforations specially made in the roll.

The pneumatic sustaining device has little to recommend it apart from this automatic feature,

as it is generally slow, noisy and power-consuming to a distressing degree.

These remarks complete the general survey of player mechanism which forms Parts 1 and 2 of this work. I now invite the reader's attention to Part 3, wherein are comprised descriptions of such individual systems of player mechanism as are sufficiently important to deserve special and separate mention.

PART III

INDIVIDUAL MECHANISMS DESCRIBED

Chapter I.

The foregoing pages have dealt with the fundamental principles of pneumatic piano playing mechanism and have explained the physical laws involved, together with their application to the subject under discussion.

I now proceed to a description of some leading mechanisms now on the market and in use.

It has of course been impossible within the limits of my space to make separate description of every extant player mechanism, and what follows is intended only to emphasize the individualities of the leading examples.

This part of the work is especially intended for the use of tuners and repairmen, as a guide to them in the work of regulating and repairing, and above all, as a sort of map whereby they may acquaint themselves with the ground they are traversing when they undertake to explore unfamiliar players.

It is impossible in a book like this to emphasize all the various claims put forth by manufacturers, and my intention in this part has been merely to afford the practical information, gained through

personal contact with the mechanisms described, which may be desirable for the purposes indicated above.

The Æolian Company

THE PIANOLA

The mechanisms manufactured by this company and known as "Pianolas," are for the exclusive use of the Æolian line of grand and upright pianos. In addition to these, the Æolian Company continues to manufacture a certain number of exterior playing mechanisms of the cabinet type, which are used considerably in foreign countries.

The mechanism produced by this company is made in their own factories and contains many original features which have given the Pianola fame. The name Pianola has become an almost generic term for player-piano, although it is the exclusive property of the Æolian Company. The Pianola is noted for its originality, its high class of workmanship and for its distinctly artistic character.

The interior Pianola mechanisms are of wide variety in constructional detail, although following the same general design. The entire Æolian

line of grand and upright pianos is fitted with one or another style of these Pianola mechanisms, each especially adapted to its particular purpose. Description must therefore be somewhat general.

Bellows-System. The general Pianola design is of the indirect variation type with single equalizing unit, the expression and motor governors being usually carried on the upper action. Special folding pedals are used, and in the grand Pianola mechanism these fold up inside the lyre box, which also carries the exhaust units.

Pneumatic Action. Both the double and single valve systems have been largely used in Pianola practice. Older models were built with pneumatics and valves below the key-bed, but this method has been superseded for several years by the modern plan of [illegible]ing the playing system in front of the piano action. In the grand mechanisms the pneumatic and valve system is housed beneath the key-bed.

Tracker-Box. In upright mechanisms this is placed above the pneumatic action. Carries tracking device, uses rubber tubes, and has metal bar fitted with marginal perforations for automatic sustaining pedal, and Themodist (automatic accent). Metrostyle (tempo guide) pointer is car-

ried on tempo indicator. Switches for Themodist and automatic sustaining pedal also carried on tracker box. In grand mechanisms, the tracker-box is carried behind the fall board. Some models have combination 65 and 88 note scales.

Motor. The typical Pianola motor is of the Pneumatic 6-point type, having three double units. This arrangement was originated in Pianola practice and has been very successful. Older models will be found with three point motors. The gear shift and action cut off on these have always been of the direct mechanical type, lever manipulated. In recent practice a three-way control of the rewind lever has been adopted.

Governing Devices and Control. The expression control of the Pianola mechanism has ever been elaborate and inge[illegible] The most important feature is undoubtedly the Themodist. This consists of a by-pass arrangement in the double divided expression governor. The latter consists of two expression governors, one for the treble and one for the bass of the action. The Themodist arrangement cuts off the governor so that suction is through the action direct, thereby assuring high pressure operation of the pneumatics. When the Themodist switch is on, the perfora-

tions in the margin of the roll co-act with the Themodist tracker perforation and the inrushing air operates a small pouch which works the Themodist valve. The suction passes through the governor when no perforations are co-acting, as it is switched that way as soon as the Themodist lever is thrown on. The action of the Themodist is to break this government of the suction temporarily, by cutting off the governor and instantly putting it in action again. Hence the perforations are on either margin of the tracker and roll, as one governor cut-off is needed for each governor. The position of the governors differs in various models. The expression governors can also be operated by direct finger levers, and a recent development also gives control over them through a side-way movement of a special type of tempo lever.

The motor governor is of bellows type, and the motor valve is operated by means of a tempo lever on the key-slip. Action cut-off and gear-shift are worked by a re-wind lever, which also has a third position, whereby the action cut-off is operated but the gear not shifted, so that the motor drives ahead without the action playing.

There is a pneumatic for sustaining pedal op-

eration through a marginal perforation, and also a direct finger lever connection for personal control.

Various other expression devices have been used at one time or another on the different styles of Pianola mechanism, but the above description embraces the typical and most important. The Æolian Co. is constantly experimenting towards the production of a standard and perfectly efficient type of control and thus its methods are in a state of constant flux, ever approaching nearer to perfection.

The Amphion Co.

THE AMPHION

The Amphion Piano Player Company, Syracuse, New York, manufactures several models of pneumatic piano playing mechanisms incorporating the well known features of the regular Amphion mechanism, as well as special features and devices made exclusively for such manufacturers.

Amphion mechanisms are sold only to manufacturers of pianos, and are installed by many different piano manufacturers. A special feature of this action is the unit construction whereby each part is made, tested and installed as an

independent and interchangeable unit, as, for instance, the bellows, the pneumatic action, the motor, the governor, the cut-off box, and the expression devices.

Should any unit be damaged, or should considerable advance be made on any part in the development of the pneumatic art, the unit so damaged or improved can be instantly replaced with a new unit without taking down the mechanism and without any relation to any other part thereof.

Bellows System. Direct variation type. Two exhaust units and one equalizer. Folding pedals that automatically move into position by opening the door in the lower front panel of piano.

Tracker Box. Carries an automatic tracker device, operated by double pneumatics under balanced air pressure. Tracker equipped to operate sustaining pedal automatically, when music roll carries perforations for that purpose. Reroll lever in tracker box or key-slip, as desired. Tubing either rubber or brass.

Pneumatic Action. Single valve system—three deck type. Air throughout this action is conveyed through independent tubing and not through holes in the wood. No packed joints, except one that is held together by a bolt with compensating

washer. Valves, vertical gravity type. Vents, carried in separate unit.

Motor. Six point pneumatic. Motor-valves, operating on double ported base made of non-corrosive "silver metal." Mechanical gear shift, operated from tracker box to key-slip. Cut-off operated pneumatically. The port for operating the same carried by the same frame-work as the reroll shift. Motor Governor, equipped with automatic spring tensioning device, with the result that its spring is variable in tension according to the load put on the governor.

Expression Devices and Control. Double divided hammer rail lifters, controlled by buttons or levers in the key-slip. Some models have three divisions of hammer rail, controlled by three buttons in the key-slip. Pne[redacted]e sustaining pedal device, controlled by button or lever in the key-slip, or automatically from the tracker box. Some models have finger levers controlling the whole of the hammer rail.

Removal and Replacement. Each unit of the player action can be removed by removing not more than four (4) screws and detaching the tubing, independently of any other connections.

The American Piano Co.

THE STODDARD-AMPICO

This mechanism is manufactured by the American Piano Co., which company controls a number of leading pianos, and is applied only to instruments made by them.

The general design of the Stoddard-Ampico is that of a player-piano fitted with motor driven bellows-system, instead of the usual foot-driven power-plant. Its expressive capacities are controlled through expression governors of special type, which are adapted to be actuated either automatically through marginal perforations in the tracker-bar in combination with special rolls, or manually by the performer through finger buttons.

The special rolls are records of actual piano playing by artists. They, therefore, contain the pianist's phrasing in the cutting of the notes, while marginal perforations are added from records also made of the artist's dynamic interpretations, pedaling and so on. Thus a complete reproduction of an artist's performance may be had by means of the Stoddard-Ampico.

As noted above, however, the Stoddard-Am-

pico is not merely a reproducing piano, but may also be used as readily for the direct expression of the individual performer's ideas.

Pneumatic Action. This is of the Auto-pneumatic type, as described elsewhere in this work, to which refer.

Bellows-System. Driven by electric motor (using either direct or alternating current) from ordinary light circuits. Alternating current motors are placed directly in piano. Whole bellows-system is hung inside piano behind bottom frame and may be swung outwards on floor complete.

Governing Devices and Control. Expression (dynamics) governed through roll by means of two expression governors, one for bass and one for treble divisions of action. These governors can regulate tension progressively as controlled by pneumatic switches operated by marginal perforations in roll. There is also an arrangement whereby the expression governors may be controlled manually, when ordinary rolls are used, by the depression of finger buttons on keyslip. These buttons, when covered by the fingers, shut off the air passage to the expression governors and reduce the tension to low. When depressed they

gradually raise the tension, till same is at its highest when buttons are entirely depressed.

Sustaining pedal of piano may be used when pneumatically playing with ordinary music rolls, on account of absence of pumping pedals. Pneumatic sustaining pedal device is operated through marginal perforations in special rolls.

When piece is finished the roll is automatically rewound, and when this operation is complete the electric motor is automatically shut off.

The driving of the roll and rewinding of same are operated by the customary pneumatic motor.

American Player Action Co.

This mechanism is manufactured by the American Player Action Co., of New York, and is supplied by them to various piano manufacturers for installation. It contains many original features of design and construction.

Bellows-System. Direct variation type. Two exhausters. Two equalizers; high and low tension. Bellows-system carries motor governor and action-cut-off boxes at top to right and left respectively. Bellows-system mounted on trunk channel board and is detachable as an unit. Spe-

cial pedal leverage system. Flap valves on front or fixed wall of exhausters.

Pneumatic Action. Single valve system. Vertical valves of entirely new design, in three banks, controlling vertical pneumatics similarly disposed. Thus there are three distinct reduced pressure chambers, each with separate detachable covering board. Vents are immediately in front of valves and can be reached at once when boards are removed. Pneumatics have regulating screw for throw of pneumatic and similar regulation for taking up lost motion, which are accessible from the front. Pneumatics operate through adjustable bell-crank on lugs fastened to abstracts of piano action.

Tracker-Box. Carries automatic balancing tracking device. Tracker-duct tubes are of rubber or metal as preferred.

Motor. Four point pneumatic. Special valve system, involving valve motion in ellipse by freely balanced valves working on seats set at right angles from motor frame. Transmission gears mechanical, with permanent meshing of large gear wheel and pinion.

Governing Devices and Control. Motor control is provided by motor governor on back of motor

valve box. Governor carries special suspended conical non-corrosive valve tongue. Also carries screw for regulating closing of governor, thus enabling alteration of speed ratios. Motor valve-box has special motor speed regulation in form of conical valve working in circular port. Motor valve box is built in one piece without joints of any kind. It contains also the motor re-wind drive valve. Motor valve is controlled by tempo lever on key-slip. Re-wind lever on key-slip controls motor re-wind drive valve in motor valve box, and by same motion action cut-off valve in action cut-off box at left of bellows-system.

Removal and Replacement. Pneumatic Action, tracker-box and motor come out from piano in one piece by removing side screws and disconnecting suction tubes at either end. Bellows-system comes out after similar fashion also in one piece, leaving entire piano free and clear.

Auto Pneumatic Action Co.

The Auto-Pneumatic mechanism is manufactured by the Auto Pneumatic Action Co., New York, one of the best known in the industry. This mechanism is installed as regular equipment in a very extensive line of pianos.

Bellows-System. The complete bellows-system is built in two sections and contains the governing devices as well. Indirect variation type. Two exhausters. Two equalizers, one high and the other low pressure. Removable from the piano in two sections. Special pedal leverage connections whereby power is transmitted from the feet to the middle of the exhauster unit. Special folding pedals. Auxiliary valve inside equalizer to facilitate high tension exhaust when accenting is required.

Pneumatic Action. Double-valve type. Primaries vertically housed in chest immediately below tracker-box. Secondaries horizontally housed in secondary chest immediately above key-board. Vents accessible from front of primary chest. Special seating devices for secondary valves. Pneumatics operate on wippen of piano action through flexible connecting finger. Exhaust trunk to bellows is in form of heavy wooden block fastened to key-bed and running through same. Action can be removed by taking out end screws and lifting forward.

Tracker-Box. Straight 88-note or combination 65-88 note range. Has marginal perforations for automatic tracking device to help the music sheet.

racker-duct tubes are metal. Automatic trackng device at left of track has two pneumatics nd double valves operate through marginal perorations on music roll chucks.

Motor. 5-point pneumatic. Mechanical transiission and rewind gear.

Governing Devices and Control. Motor goveror of jack-knife type on bellows at right side, toether with motor valve-box containing tempo alve and motor rewind lever to control rewind alve and action cut-off, which latter is on bellows t left side. Auxiliary tempo-lever for rapid hanges operating auxiliary motor-valve box. pecial auxiliary accent by-pass valve in equalizer esponds to foot pressure on pedals. Doubleivided hammer-rail operated by lifter pneuiatics on each side below key bed. Sustaining edal pneumatic either for button control or for utomatic through marginal perforation on racker. Direct lever control also used.

Removal and Replacement. Pneumatic action nd entire superstructure come out in one piece s above described. Each of the two sections of he bellows comes out separately by disconnectng hose and two thumb-screws at the top. Tuner eed not remove top action for tuning, as there

is room for insertion and removal of tuning wedges.

The Autopiano Co.

THE AUTOPIANO

This mechanism is manufactured by the Autopiano Co., of New York, and is used in the player-piano produced by them.

Bellows-System. Indirect variation. Two exhausters and one equalizer. Bellows-system carries expression and motor governors. Special folding pedal system.

Pneumatic Action. Double valve system. Primaries are vertical and secondaries horizontal. Upper part of action can be detached, leaving valve chests and pneumatic stack in piano. Secondary pouch board is in front of action and can be taken out without harming valves.

Tracker Box. Has automatic tracking device controlled by marginal perforations in trackerbar which actuate double pneumatic and double valve system to left of box for shifting position of music roll chucks automatically to preserve tracking. Tracker tubes are metal.

Motor. 5-point pneumatic. Mechanical transmission.

Governing Devices and Control. Sustaining ever for left little finger operating directly on lamper lifter rod. Double divided hammer rail ifting pneumatics operated by buttons on key- lip controlling pneumatics above action at either nd. Accent lever controlling operation of ex- pression bellows-type governor on bellows-sys- em. Tempo lever controls tempo valve in mo- or governor box. Re-wind lever controls rewind notor drive valve in motor valve box and action ut-off in action cut-off box to left under key-bed. Sustaining pedal pneumatic operated by button nd automatically through marginal perforation n tracker with same in special music rolls, also itted.

Removal and Replacement. Tracker-box and notor need not be disturbed for tuning, but can e removed separate from pneumatic action by oosening end screws. Pneumatic action also de- achable by loosening long screws in front at left ide of secondary pouch board and long screw at extreme right. Bellows-system can be taken out in one piece with pedals by disconnecting tubes and rods and removing end screws.

The Baldwin Co.

THE MANUALO

The player mechanism known by this name is the product of The Baldwin Company of Cincinnati, and is exclusively applied to the line of pianos manufactured or controlled by them. It possesses many features of original design and construction.

Bellows-System. Direct control of accentuation by foot power instead of control by handles or chokers. Circular metal escape valves on the two exhausters. Both outer and inner valves accessible from the front for regulating or cleaning. Special folding pedal leverage whereby exhausters are drawn downwards towards the foot when operated. Equalizer is parallel acting instead of with hinged leaves, with accent block to change the bellows quickly from low to high tension.

Pneumatic Action. Single valve system. Lateral acting valve in chest under pneumatics. Combination valve, pouch and stud. Valve chamber walls sealed with rubber cloth. Pneumatics are graded in size from bass to treble and are directly connected with the abstracts of the piano action by a lever attached to and extending

·om their moving wall. Valves are visible while ı motion and accessible from front of player ac- on for regulation.

Tracker-Box. Above pneumatic action contain- ıg tracker bar, tempo indicator, re-wind handle nd thumbscrew adjustment for music roll ıucks to assist correct tracking. Tracker-ducts re rubber and continuous from action to tracker ithout joints.

Motor. 4-point pneumatic. Mahogany valves nd seats. Mechanical transmission gear.

Governing Devices and Control. Motor gover- or on front of bellows-system with tempo valve ox controlled by tempo lever and also by two uttons for retard and acceleration which act on ubsidiary valve in valve box, thus affording in- ependent tempo control.

Two hammer-rail lifters and one sustaining edal pneumatic are operated by buttons. A pecial folding tempo handle and all buttons con- rolling expression devices are mounted in a solid ey-slip in an accessible and convenient position.

The Behning Piano Co.

THE BEHNING

This player mechanism is manufactured by the Behning Piano Co., is of their own design, and is used exclusively in the Behning pianos. It is distinguished for a high class of workmanship, for ingenuity of design and above all for its markedly artistic character.

Bellows System. Indirect variation type. Exhaust and equalizing units with special form of escape valves. Special folding pedals.

Pneumatic Action. Double valve system. Secondary valves housed immediately above ports of pneumatics, avoiding long air passages. Primaries immediately in front of secondaries. Action in two banks. Regulating screws for pneumatic touch depth and for lost motion. Pneumatics engage directly with piano action abstracts. Vents massed in one chamber immediately above secondaries where tubing comes in from tracker.

Tracker-box. Housed level with tuning pins. Carries pneumatic tracking device operated by contact flange bearing against paper. Rubber tubing.

Motor. 6-point pneumatic. Special form of de valves. Mechanical transmission gear.
Governing Devices and Control. Pneumatic staining pedal lifting device, operated by but- n on key-slip. Double divided hammer-rail lift- s controlled by buttons on key-slip. Expression vernor and box controlled by thumb lever on y-slip. Tempo-lever on key-slip controlling mpo valve in tempo valve box. Motor gover- r in connection. Re-wind lever on key-slip con- olling motor re-wind drive valve and action cut- f in motor and expression boxes respectively.
Removal and Replacement. Tracker box and eumatic action may be removed together by re- asing braces, tempo lever connections and umb-screws at either end of action. Bellows- stem is detached in similar fashion.

Behr Brothers & Company

The player mechanism in the Behr Piano is used clusively by Behr Bros. & Co.
Bellows-System. Two exhaust units with high d low pressure equalizers. Special folding dals. Bellows structure carries expression gov- nors (2). Motor governor is carried at right

hand side of bellows, separate from main structure.

Tracker-box. Standard type. Change gears of motor located outside entirely, at left of tracker-box.

Pneumatic Action. Double valve system. Primaries are carried in pairs, each pair in a separate detachable box, containing also special form of vent in shape of hole bored in small brass tube, which may be removed at once for cleaning. Primary pairs can be unscrewed readily, as all are assembled in a line at top of action immediately under tracker-box. Secondaries are contained each in unit form with pneumatics. Each pneumatic is separately detachable by removing front board of action, loosening action and drawing forward, disconnecting piano action connection of pneumatic involved and loosening pneumatic set-screw. Pneumatic then can be withdrawn with secondary in one piece.

Motor. Six point unit type with special form of valve.

Governing Devices and Control. Hammer-rail is divided, with pneumatic lifters controlled by two buttons on key-slip. In addition to the pedal accenting, which is promoted by means of the special

cent valve in the equalizers, there are two governors, dividing the action pneumatically, and aced behind the equalizers. These normally rry the flow of displaced air, so that normally e action plays softly. When it is desired to act on either side, the corresponding button is pressed, switching displaced air direct to bellows. Thus accentuation may be rapidly accomished. If the performer so desires, the two buttons controlling this device may be locked by eans of a lever underneath the key-bed, thereby nverting the mechanism into that type of player ierein the expression and accenting of individual tes and chords is obtained by direct pedal tion. The motor government is accomplished means of a governor placed at the right side of e bellows-structure.

Removal and Replacement. The entire top acn can be removed by detaching braces at top, sconnecting suction tubes and loosening screws sides. Bellows removed similarly. For tung purposes it is only necessary to remove brace top running to piano plate at treble side.

Berry-Wood Piano Player Co.

This name is given to a line of automatic coin-controlled player-pianos manufactured by the Berry-Wood Piano Player Co., of Kansas City, Mo., and New York. The general type is similar to that which is described elsewhere in this work, but the following points may be observed.

Bellows-System. Special Berry-Wood motor driven type. Especially powerful type used for Orchestrions. D. C. or A. C. motor as required.

Pneumatic Action. Single valve type. Specially simple for hard and continued work.

Special Devices. In addition to the general line of coin operated pianos, which include endless roll and re-wind types, this company puts on the market larger styles in which organ pipes and pneumatically operated traps are included. The organ pipes are voiced for flute and strings. In addition there are pneumatics for operating bells, drums, cymbals, etc. All these are housed within the case. The "auto-orchestra" manufactured by this company vary in size and completeness, the largest being virtually equivalent to a 10-piece orchestra.

Otherwise, the general description of coin-op-

ated instruments given elsewhere in this work ll be found to apply to the present case.

The Cable Company

CAROLA INNER-PLAYER

This mechanism is the exclusive property of e Cable Company, Chicago. It possesses many atures of original and individual interest.

Bellows-System. Indirect variation type. uilt in two separable sections, each containing e exhauster and one equalizer. The equalizers e spring-expanded for high and low tension re-ectively. These four units are housed hori-ntally, equalizers below exhausters. Movable lls face forward, so that flap-valves, expansion d compression springs and bearings of pedal ls, are immediately accessible. Special pedal erage arrangement with rolling anti-friction ntact. Special triplex pedal-release system, ereby pedals, bottom panel and lever-covering ist-rest-rail are automatically thrown into play-; position by the movement of a single lever un-: key-bed, and automatically returned to nor-l closed position by pushing wrist-rest-rail k into place.

Pneumatic Action. Single-valve system.

Valves housed, each beneath its corresponding pneumatic, in two banks. Reduced pressure chambers are therefore two in number. Pneumatics operate from front and engage with front end of miniature key-levers, pulling down front of same. Other end of each lever engages with piano action abstracts. Miniature key-levers are balanced similarly to manual keys, giving same ratios. Contact of pneumatics through miniature keys with piano action can be regulated by means of regulating buttons situated at front of the key-levers and immediately accessible.

Tracker-box. This, together with motor and transmission, is mounted on a superstructure board immediately above piano hammers. Music sheet is movable for alignment or transposition to any higher or lower key by means of knurled wheel on base of box. Music-roll take-up spool and chucks are moved laterally when tracking and transposing device is operated. Tracker-bar remains fixed. Tracker-duct tubes are rubber.

Motor. 6-point pneumatic, having three double units and three slide valves. Mounted on superstructure. Transmission of novel type, having straight line drive to take-up spool with pneumatic clutch control which meshes gears positively

thout stripping. Sprocket and chain used only
. re-wind. Bearings are conical, with babbitt
etal bushings. Shifting forks are fibre. High
ade steel used for moving metal parts.

Governing Devices and Control. Direct lever
mper-lift for sustaining pedal. Tilting tablet
erating divided hammer-rail-lifter pneumatics.
pression governor on left of bellows-system,
th accent valve in same box with action cut-off
lve. Expression control through thumb lever
rking on accent valve. Motor governor and
tor valve box on right hand side of bellows-
tem, motor valve being controlled from tempo
er on key-slip. Re-wind lever controlling mo-
-rewind-drive valve and action cut-off.

Removal and Replacement. For tuning, entire
erstructure, carrying tracker-box, motor and
nsmission, slides forward and downward far
ugh to leave room for insertion of tuning
lges, etc. No disconnections necessary for this
pose. To remove superstructure, same is
wn forward after disconnecting tracker-duct
es at metal nipples on action, tempo rod, and
ber suction tubes at motor, and when it stops,
h springs under it are pressed downward, when
erstructure may be drawn off. To remove

pneumatic action, tracker duct tubes are detached from their metal nipples on action, large rubber tube at right end from motor is also disconnected and end screws are loosened. Pneumatic action and superstructure can be removed together without disconnecting tracker duct tubes but can be taken out separately, either one, as above. To remove bellows-system, disconnect center rubber tubes, take out large thumb-screws on each separable unit, disconnect valve wires and motor suction tube, also action suction tube. Remove bearing plates of pedal levers and disconnect triplex pedal-release rods. Bellows-system then will come out in two sections. When removing right hand section only, pedal release system need not be touched.

The A. B. Chase Co.

THE ARTISTANO

Manufactured by the A. B. Chase Co. of Norwalk, Ohio. The Artistano mechanism is adapted both to grand and to upright pianos. It is distingished for being entirely self-contained, and is detachable in one piece from the piano. All parts of it are below the key-bed. The complete mechanism may be operated after being detached.

Bellows-System. Indirect variation. Two exhausters. One equalizer. Governors for motor and expression are carried on front of bellows trunk.

Pneumatic Action. Double valve system carried on two boards, with primary pouches and secondary disks on outside and secondary pouches and primary disks on inside. Pneumatics act directly upward on regulating screws which pass through the abstracts; pneumatics being below key-bed.

Tracker-Box. Immediately above pneumatics and below key-bed. Can be folded away when not in use, this action also folding up the player pedals and door. When used in playing rests in front of key-slip. Tracker tubes are metal. Contains tracker-regulating screw on right hand music-roll chuck.

Motor. 4-point pneumatic. Glass slides. Attaches at right of tracker above pneumatics.

Governing Devices and Control. Thumb lever damper-lift. Finger-levers operating valves in expression governors on front of bellows. One governor for bass side of action, one for treble.

Combination re-wind and tempo lever, operat-

ing valves in tempo box. All levers assembled on tracker box. Automatic hammer-rail lift.

Removal and Replacement. Complete mechanism swings on hinges below key-bed. To remove, mechanism is swung outwards to angle of 45 degrees with piano. Lower hinge pin is removed and mechanism can then be lifted off upper pin. Two persons are required to do this conveniently.

Grand mechanism is fastened by four screws to key-bed. When these are removed, mechanism sinks to ground supported on lyre and folding legs and can be removed.

Christman Piano Co.

CHRISTMAN ATTACHABLE

This mechanism is manufactured by the Christman Piano Co. of New York and is of special type, designed for attachment to any upright or grand piano.

Bellows-System. Direct variation type. Two exhaust units and one equalizer. In upright mechanism, this fits below the key-bed in usual position. In the grand type the bellows-system is housed in special box that takes the place of the usual lyre-frame. The motor governor and valve box, with action cut-off box, are housed on the

bellows-system structure. Special automatic folding pedals.

Tracker-Box. In both types is arranged to fold away under key-bed, being pulled outwards till it rests in front of keys when in playing position. The two ends of the roll-holding units carry the tempo and expressive control devices respectively. When tracker-box is pulled forward or thrown back, doors of lyre-frame in grand or of bottom frame in upright open and close. Tubing is rubber. Tracker has automatic tracking device.

Pneumatic Action. Single valve type. Pneumatic units carry valve in same structure. They are laid in one row directly under piano keys, being supported on special form of frame which carries suction trunk. Each pneumatic is connected with key above it by a cord, which is carried through a hole drilled in key to top of same where it is adjustably secured.

Governing Devices and Control. Tempo and rewind combination lever at right side on right hand roll holding unit. Double divided hammer rail lifts controlled by buttons on left hand unit. Pneumatic sustaining-pedal device controlled by button on left hand unit. Pneumatics for all

three are above hammers on upright. Motor governor and valve box, with action cut-off box on bellows system.

Melville Clark Piano Co.

THE APOLLO

The general name Apollo is given to the piano player mechanisms manufactured by the Melville Clark Piano Co., of Chicago. Under this title is embraced a number of varieties, including the without electric drive, and the special Solo-Apollo Apollo Grand, the Solo-Apollo Grand, with and without electric drive, and the special Solo-Apollo Grand with separated control cabinet. The Apollo mechanism is simple and highly ingenious. The general make-up of the standard Apollo action is as follows:

Bellows-System. Direct variation type. Exhaust and equalizing units sometimes horizontally placed (in older models). Pedals either folding or (in older models) detachable from bellows units.

Tracker-box. Tracker carries special transposing device giving various key changes, operated by thumbnut.

Pneumatic Action. Single valve system, using

bellows-valve. Pneumatics engage directly on upper surface of keys, behind fall-board, pressing downwards.

Motor. Either mechanical spring-operated or pneumatic.

Governing Devices and Control. Pneumatic sustaining pedal operated by lifting pneumatic, controlled either through button or marginal perforation in tracker. Hammer rail lifting pneumatics controlled by buttons and perforations. All buttons in key-slip. Tempo lever combined with re-roll springing from beneath key-bed.

Solo and Special Devices. The Solo-Apollo is a special type of Apollo mechanism and consists essentially of the combination of the ordinary mechanism with a special Solo action. This latter operates as a complete unit, controlled by its own special perforations in the tracker-bar, which is enlarged for the purpose. The Solo action operates at a higher tension than the ordinary action when the two are played in combination; this being controlled by the usual type of expression governors. Special rolls are used in which the notes of a melody are assigned to the Solo action while the ordinary action plays the accompaniment notes. In this way it is possible

not only to obtain excellent accentuation and emphasis of melodies, but also, if necessary, to cut off entirely either the solo or the accompaniment action, so that either may be silent while the other plays.

In addition to this special mechanism, the Solo-Apollo is often provided with a tempo control of pneumatic type, in which the tempo controlling lever is shifted automatically in position through the agency of special perforations in the margin of the music roll and tracker-bar whereby pneumatics are operated through special valves. Later developments have extended this idea to the expression devices, and through similar perforations it is now possible to control the expression tension automatically. An extension of the idea is provided in the electrically driven Solo-Apollo recently put on the market which can be used with both grand and upright pianos. In this the bellows system and electric motor, together with the controlling levers (for use when the automatic controls are not employed) are installed in the upright piano and in the grand are placed in an exterior cabinet, and connected with the pneumatic action under the key-bed by means

of tubes. The cabinet can be pushed under the grand piano when not in use.

Jacob Doll & Sons—Inc.

The player mechanism manufactured by this company is used exclusively in their line of pianos.

Bellows-System. Indirect variation type, with two exhaust units and one equalizer. Bellows-system carries large governors for motor and expression, to right and left respectively, in front of exhaust units. Expression valve box and motor valve box are carried above and separate from bellows-system.

Tracker-Box. Carries finger lever for tracker adjustment and transposition. Tubing to valves is rubber.

Pneumatic action. Double valve type. Pneumatics face forward, and engage with piano action through rocking levers.

Motor. 5-point pneumatic. Mechanical gear shift and re-wind.

Governing Devices and Control. Expression governor situated at left side of bellows system in front of left hand exhaust unit. Valve box for expression is situated directly above governor with

tube connection. Expression control is through lever worked by left thumb. Motor governor is at right of bellows-system, in front of right hand exhaust unit, with motor valve box containing motor tempo valve and motor re-wind valve immediately above it, controlled by tempo lever and re-wind lever. Action cut-off is in expression valve box. Finger lever on key-slip for sustaining pedal device and double divided hammer-rail lift controlled by buttons operating hammer-lifting pneumatics on right and left ends of piano above hammers.

Note. A modified style of the above mechanism is also manufactured, in which an electric motor is used to operate an additional set of exhaust units. The expression devices are the same but may be operated automatically by means of marginal perforations in special music rolls, which actuate pneumatic valves in the expression and motor boxes, and in the hammer-rail lift pneumatics. There are also a button for controlling the general level of tension, which acts on the expression governor, an electric switch connected with the source of current for starting and stopping the motor, and a further button for throwing in or out the automatic expression.

Electrelle

This mechanism is manufactured by the American Piano Co. and forms part of their line of player mechanisms. It can be installed in any upright or grand piano.

The design and construction of the Electrelle are so far different from those of pneumatic mechanisms that a special method of description is here adopted.

Principle of Operation. A small electric motor rotates a polished steel rod fastened above and parallel with the hammers of a piano. A series of small electro-magnets is arranged in a row adjacent to the rod with the armatures connected with cork-lined shoes. The latter, when the magnets are energized, move forward, and the shoes catch on the revolving rod, which holds them up until the de-energizing of the magnet, when they return to the original position. The shoes being connected by means of tapes with the wippens of the piano action, the latter is operated accordingly.

Selection and Control. An ordinary music roll is used, which is carried over a tracker bar on which, instead of holes, are pairs of very light

wires. Above the paper roll is arranged a conducting bar carrying current from a battery or light circuit, which also furnishes current for the motor. When perforations occur in the paper, the pair of wires which register with the perforation spring upwards and connect with the conducting bar, thus completing a circuit and energizing the corresponding magnet. When the wires are covered by the paper, they are insulated from the conducting bar and no circuit can be made.

Motor and Motive Power. The current from a battery or light circuit runs a small electric motor which revolves the rod and also the take-up spool of the tracker-box. No transformer is needed. Motor is controlled as to speed by a delicate rheostat governed by a finger lever. Magnets are energized by same power.

Position of Elements. Tracker-box carrying take-up spool, conducting-bar and tracker-bar with its pairs of wires, folds away under key-bed when not in use, and when in use is pulled forward till it comes to rest in front of the piano keys. Magnets and revolving rod with connections and motor are above piano hammers. Motor can also be placed in bottom of piano.

Expression Control. Sustaining and soft ped-

als of piano may be operated as usual by feet of performer. Motor control is as described above. Touch or dynamic control is obtained as follows: A jointed rod is placed behind the line of hammers and so arranged that when the tracker-box is pulled forward for electric playing, the hammers are raised automatically and held very close to the strings. Each section of the jointed rod is controlled by a finger key which pulls out from below the key-bed. There are three sections of the rod and three keys. By depressing a key, the performer pulls back the corresponding section of hammers, thus bringing that section to full distance of hammer stroke or to any intermediate distance. In this way complete touch control can be had, virtually on each and every individual tone of the piano.

Euphona

This mechanism is manufactured exclusively by The Cable Co. of Chicago, and is standard equipment for certain player-pianos manufactured by them.

Bellows-system. Direct variation type. Two exhausters, one equalizer. Controlling devices

carried on top of bellows. Pedals fold against fixed wall of bellows when not in use.

Pneumatic action. Single-valve type. Pneumatics engage with piano action abstracts direct.

Tracker-box. Tracker bar carries perforation for automatic sustaining pedal pneumatic. Thumb-nut for mechanical tracking device. Tracker-duct tubes are rubber.

Motor. 6-point pneumatic with 3 double units, and slide valves.

Governing Devices and Control. Motor governor in connection with motor valve box above bellows-system and attached to it. Motor valve box controlled by combination tempo and rewind lever, which also acts on action-cut-off valve box at other end of bellows-system. Double divided hammer-rail pneumatic lifters controlled by buttons on key-slip. Sustaining pedal button on key-slip controlling sustaining pedal (damper-lifting) pneumatic at left side of bellows under key-bed. Extra perforation in tracker bar for controlling sustaining device automatically through special perforations on rolls.

Removal and Replacement. Pneumatic action, tracker-box and motor can be withdrawn together by detaching motor suction tube, motor rod con-

nections and large screws at either end of pneumatic action. Bellows-system is removed by detaching suction tubes, disconnecting valve rods and taking out large screws at either end of bellows frame.

The Farrand Co.

THE CECILIAN

This mechanism is manufactured by the Farrand Co., of Detroit, Mich. It is applied to a line of pianos manufactured by the Farrand Co.

Bellows-System. Indirect variation type. Equalizing and exhausting units. Folding pedals.

Pneumatic action. Metal Type. Double valve system. Primary and secondary valves, with pneumatics, are built each set as an unit, detachable individually from the action. Thus each unit consists of the pneumatic (wooden) a secondary box (metal) containing secondary valve and suction passage to main air trunk, with metal primary valve box in front containing primary of standard type.

Tracker Box. Carries mechanical tracking system whereby chucks and take-up spool may be moved together for tracking through finger lever

on key-slip. Also has transposing device for shifting up or down five notes.

Motor. 5-point pneumatic. Mechanical transmission gear.

Governing Devices and Control. Direct thumb lever sustaining pedal device. Double divided expression boxes with expression governors on bellows-system controlled by buttons on key-slip. Tempo lever controlling motor re-wind drive valve in tempo box and action cut-off valve in expression box.

Removal and Replacement. Pneumatic action detachable in one piece by disconnecting rods and removing screws at ends. Bellows system detachable in similar manner.

Gulbransen-Dickinson Co.

GULBRANSEN PIANO PLAYER

This mechanism, manufactured by the Gulbransen-Dickinson Co., of Chicago, is installed in many well known pianos. Its general construction and design are quite novel, involving much original practice. The Gulbransen mechanism has in consequence earned an individual place for itself.

Bellows-System. Direct variation. Two exhausters and two equalizers. Special pedal leverage, whereby exhausters are pulled forward on the down stroke of pedals. Pedals can be removed from bellows-system without extracting screws or bolts. Response of bellows to pedal accent is instantaneous.

Pneumatic Action. Single valve system. Each pneumatic and its valve together form an unit, each unit being separately fastened to vacuum chest. Vents are collected in one line at top of chest and can be reached by removing one row of screws.

Tracker Box. Above vacuum chest. Contains tempo indicator. Has sliding tracker-bar for lateral adjustment to music roll. Tracker duct tubes are rubber.

Motor. 6-point pneumatic. 3 cylinders with pistons and connecting rods, controlled by reciprocating valves. Each cylinder double acting. Another model has all valves concentrated into one rotary unit at trable end of motor. Motor controlling valve is contained in motor frame.

Governing Devices and Control. Motor governor is of bellows type and is located on bellows system. Action cut-off box and re-wind valve box

are on either end at top of bellows with mechanical connection from same to combination tempo and re-wind lever under key-slip. Two hammer rail lifters controlled by buttons through pneumatics, and one sustaining pedal pneumatic controlled by button; all buttons on key-slip.

Removal and Replacement. For tuning, tracker and motor can be swung forward out of tuner's way. Pneumatic action can be removed by disconnecting braces at top and bottom and removing the screws at each end and disconnecting the rubber tubing.

Bellows-system comes out in one piece by removing bolts at top of bellows-system, disconnecting rubber tubes at ends, but pedals should be pushed in when this is being done.

Pedals detach separately.

Hardman, Peck & Co.

AUTOTONE

This mechanism is manufactured by Hardman, Peck & Co., of New York, and used exclusively in the pianos made by them or under their supervision.

Bellows-System. Indirect variation system.

Two exhaust units and one equalizer. Special patented folding pedals. Expression governors and expression boxes (2 in number) are carried on either side of exhaust units.

Tracker-Box. Tracker bar of metal, fitted with transposing device so that music can be played in several different keys if desired. Also carries automatic tracking device with single pneumatic and metal strip in contact with edge of paper. Tubing from tracker to primaries is rubber. Perforation for automatic sustaining pedal.

Pneumatic Action. Double Valve type, arranged in three banks. Primaries and secondaries on same frame. Secondaries vertical. Motor governor carried on upper surface at left of tracker-box.

Motor. Special 6-point type. 3 double units. Mechanical gear shift and transmission.

Governing Devices and Control. Bass and treble expression governors with corresponding expression boxes containing disk valves for switching from high to low tension and the reverse. These are situated on either side of exhaust units, as noted above, each box with its corresponding governor of bellows type above it. Action cut-off pneumatically operated through

valves in expression boxes and controlled by re-wind lever on key-slip. Valves in expression boxes are actuated by buttons on key-slip pneumatically.

Soft pedal device operating hammer-rail lift through direct thumb lever on key-slip, giving graduating soft effect.

Sustaining pedal pneumatically operated through large pneumatic situated at bottom of piano to left of bellows. Automatic operation of same through marginal perforation in tracker. Manual operation through button on key-slip.

Motor governor situated on top action to left of tracker-box. Valve box below governor in unit with it, containing tempo valve and re-wind motor valve operated by tempo and rewind levers respectively.

Silent forward drive operating action cut-off through button on key-slip.

Removal and Replacement. Pneumatic action with tracker-box and motor removable by loosening braces to piano action, disconnecting tempo rods and taking out screws at sides. Bellows-system removable in same way.

THE PLAYOTONE

This mechanism is a single valve action simplified from the Autotone, though preserving the same general ideas. The motor is identical, but the motor governor is carried below the key-bed at right of bellows. There are no expression governors or boxes, but instead hammer-rail lifting pneumatics above hammers at either side, operated by buttons on key-slip. Sustaining pedal device operated by direct thumb lever. Tubing is metal.

W. W. Kimball Co.

The mechanism is manufactured by the W. W. Kimball Co., of Chicago, and is used exclusively in their pianos.

Bellows-System. Direct variation type. Exhausters arranged horizontally and pulled downwards by pedals of special type.

Tracker-Box. Located above hammers. Tubing to valves is metal.

Pneumatic Action. Single valve type.

Motor. 4-point pneumatic. Mechanical gear shift and re-wind.

Governing Devices and Control. Double di-

vided soft-pedal device, with pneumatic hammer-rail lifters controlled by buttons on key-bed. Pneumatic for operating damper lifter controlled by button on key-bed. Mechanical re-wind lever operating action cut-off and re-wind valve in motor valve box. Tempo lever controlling motor valve. All levers and buttons assembled in key-bed with special cover.

Kranich & Bach

This mechanism is the product of Kranich & Bach of New York, and is constructed exclusively for the Kranich & Bach piano. It possesses features of marked originality.

Bellows-system. Indirect variation type. Two exhausters. One equalizer. Does not carry controlling devices on frame. These are separate.

Pneumatic action. Single valve type. Valves of special design. Each valve consists of diaphragm perforated in middle, actuated by regular style pouch and free stem unattached to either diaphragm or valve. Normally the perforated diaphragm is kept down, in usual style, with perforation closed by resting on suitable seat. When pouch moves forward under influence of air

through tracker duct, valve moves forward also and its perforation registers with port in pneumatic, thus making direct passage from reduced pressure chamber to pneumatic. Reduced pressure chambers are two in number, standing vertically, one behind the other, with pneumatics vertically fastened to them. Pneumatics make contact through bell-crank with piano action. Vents are massed on one rail above reduced pressure chambers.

Tracker-Box. Contains re-wind lever to mechanical gear shift. Tracker duct tubes are rubber. Mechanical tracking device.

Motor. 5-point pneumatic, standard type.

Governing Devices and Control. Triple division of hammer-rail actuated by pneumatics through buttons on key-slip. Sustaining pedal operated pneumatically through perforated stud in key-slip. Motor valve in motor valve box under key-bed controlled through tempo lever. Pneumatic action cut-off separate from re-wind, for cutting off action while motor drives ahead, controlled by button on key-slip. Pianissimo and accent device pneumatically throttles tension through valve and pouch in expression box under key-bed at left side, controlled through perforated

stud in key-slip. Mechanical tracker-adjuster on key-slip.

Removal and Replacement. Piano may be tuned without removing any part of action. Bellows-system arranged so as to permit access to all parts of piano below key-bed without removal. Pneumatic action together with tracker-box and motor, is detachable as an unit. Bellows-system also removable with pedals as an unit, leaving control boxes, etc., fastened to underside of key-bed.

The Lauter Co.

THE LAUTER-HUMANA

This mechanism is the product of the Lauter Company, of Newark, N. J., and is used exclusively in their pianos.

Bellows-System. Indirect variation type. Two exhausters and one equalizer. Expression and motor governors carried on bellows-system. Special type of folding pedals.

Pneumatic Action. Double valve system. Secondaries are horizontal and secondary pouch board is in front of vacuum chest, being detachable without disturbing secondary valves.

Tracker-Box. Carries automatic tracking de-

rice operating through marginal perforations in racker bar. Automatic tracker is at left of box. Also has marginal perforation controlling sustaining pedal pneumatic. Tracker tubes are metal. Tracker box detachable with motor and automatic tracking device, for tuning purposes.

Governing Devices and Control. Sustaining lever operated by little finger of left hand works directly on damper lifter rod. Double division of hammer rail with pneumatics above action at either end of piano, controlled by buttons on key-slip under fingers of left hand. Accent lever controlling closing of expression bellows-type governor on bellows-system. Tempo-lever operates tempo valve and slot in motor valve box and governor on bellows-system. Re-wind lever operates action-cut-off valve in action-cut-off box at left of piano under key-bed, and also controls re-wind motor valve in governor box.

Removal and Replacement. Upper action can be detached by removing end screws as above. Pneumatic action also is detachable by removing long screws in secondary pouch board at left end and long vertical screw at right end.

The Marquette Piano Co.

Manufactured exclusively by the Marquette Piano Co., of Chicago, who also manufacture a line of coin-operated instruments.

Bellows-Systems. Direct variation. Two exhausters. One equalizer. Special spring arrangements. Pedal leverage designed to afford responsiveness to pressure of feet without necessity for toe action. Motor governor and pneumatic re-wind box carried on bellows.

Pneumatic Action. Single valve system. Vertical gravity valves. Adjustable vents.

Tracker Box. Tracker-bar of solid brass or German silver. Rubber tracker-duct tubes. Thumb-nut tracker adjustment.

Motor. 6-point pneumatic type, with three double valves. Transmission gear carried on motor frame. Motor valve box on motor frame.

Governing Devices and Control. Motor governor on bellows controlled by double spring. Combination rewind and tempo lever on key-slip operating pneumatic action-cut-off on bellows and motor valve on motor frame. Direct mechanical hammer-lift through finger buttons on key-slip or pneumatic lift similarly controlled. Thumb lever

r sustaining pedal effect, operating damper-lift echanically.

Removal and Replacement. Bellows-system cluding pedals is detached in one piece by re-oving screws and detaching tubes. Pneumatic :tion and tracker-box with motor complete are so removable in similar manner.

Henry F. Miller & Sons Co.

This mechanism is designed and manufactured r the Henry F. Miller & Sons Piano Co. of Bos-n, and is used exclusively in their line of pianos.

Bellows-System. Indirect variation type. Two :hausters, two equalizers. Does not carry the)verning devices, but is a complete unit with its :dals, which are attached to center line of ex-ıusters.

Pneumatic Action. Double valve type. Each :imary and secondary with vent is contained in a :parate unit box which can at once be removed)r examination or regulation. Pneumatics are of ıe diaphragm type, resting horizontally in four ınks behind valve box units and operating piano :tion through rocking levers.

Tracker Box. Metal construction in one piece ith frame which holds motor. Motor is above

tracker-box. Tracker duct tubes are rubber. Automatic sustaining pedal control also on tracker at left side. Tracking device fastened to tracker box. Mechanically operated re-wind.

Motor. 5-point pneumatic of pouch type, avoiding leaves. Mounted above tracker-box.

Governing Devices and Control. Centralized system. Two boxes fastened to under side of key-bed perform following functions: Right box has motor governor and motor valve box, also pneumatic governor for treble side of divided pneumatic action, controlled by button on key-slip. Also contains control for re-wind in connection with left box. Re-wind is mechanically controlled by lever operated manually on key-slip. Left box controls right side of divided action with expression governor, and shares other controls (except motor speed) with right box.

Removal and Replacement. Bellows-system removes in one piece leaving governing devices attached to under side of piano key-bed. Top action also comes out in one piece complete by removing side screws.

The National Piano Co.

THE AIR-O-PLAYER

This mechanism is manufactured by the National Piano Co., of Boston, Mass., and is fitted to the pianos made by this concern.

Bellows-System. Direct variation type, but single by-pass expression governing box in communication. Two exhausters and one equal-. Expression and motor governors and cut-box are separate from bellows-system.

Pneumatic Action. Double valve type. The mary and secondary valves for each pneumatic contained in a seamless metal shell or cart-ge, fastened to the upper surface of the pneu-tic and to the trunk vacuum chest, and detach-e from both by loosening metal strap attached stiffening truss rods. This construction is d wherever valves are necessary throughout ion. A complete new cartridge can be sub-uted for a defective unit in a moment. Pneu-tics strike from back directly through plungers wippen of piano action and have regulating ew for regulation of dip.

Tracker-Box. Carries re-wind lever, and has chanical tracking adjuster operated by knurled

nut at left. Motor, tracker-box, motor governor and motor transmission are all carried together on one frame, forming the superstructure, which is detachable individually. Tubes are rubber.

Motor. Five-point pneumatic. Carried on superstructure to right of tracker-box. Mechanical gear shift. Motor governor immediately beneath motor.

Governing Devices and Control. Motor governor is on superstructure below motor, and is controlled by re-wind lever running into it and also by tempo lever operating tempo valve in governor valve box. Re-wind lever also operates action cut-off valve in action cut-off valve box under key-bed of piano at left side. Control levers and buttons are arranged as follows, from left to right: (1) Sustaining lever operating direct on damper lifter rod, and carrying button which controls pouch in action cut-off box, to cut off action while running ahead. This is called the "skip" button. (2) Split levers, operating bass and treble hammer lifting pneumatics above action on either side. (3) Tempo lever operating as above and carrying expression button which controls pouch in cut-off box under piano key-bed. Tempo lever also carries button which controls

ve box under piano key-bed at right. Pouch ng in this valve box cuts off motor entirely.

emoval and Replacement. Superstructure is ached by taking out screws at either end, disnecting motor suction tubes and lever connecis, and loosening screws behind, which hold ker-tubes to pneumatic action. This suffices tuning and regulating pneumatic action. umatic action can also be detached and reed. Bellows-system comes out in one piece r removing thumb-screws and disconnecting tion tubes. A small recess under the trackercontains an extra valve cartridge with hook detaching same from pneumatic action.

The Peerless Piano Player Co.

his name is given to a form of automatic or i-operated automatic player-piano manufaced by the Peerless Piano Player Co., of St. nsville, N. Y. It comes in various forms, not y as a straight pneumatically operated piano, with the addition of organ pipes, drums, castts, mandolin attachment, cymbals, etc. The est of the latter styles are known as "orchesns."

ellows-System. Electric-motor driven ex-

haust units three in number. When organ pipes are used there is also a set of three compression bellows driven by same motor. Direct or alternating current, using light circuits. Equalizer. Belt or friction drive to tracker above key-bed. Friction drive can be regulated for speed. Motor is housed in bottom or in back of piano.

Tracker-Box. Above key-bed carrying driving gear with special type of clutch for drive and re-wind. Tracker-bar has marginal perforations for all operations. Rubber tubing.

Pneumatic Action. Single Valve.

Motor. Electric driving bellows and take-up spool on tracker frame by belt or friction drive.

Governing Devices and Control. Organ feature is placed above piano hammers, and can be taken down with its casing complete. Organ pipes are tuned with test roll by putting them in unison with piano strings. Pipes have tuning slides. Main electric switch operable by hand as well as by coin slot. Start and re-wind switch in front of tracker. Soft pedal device lifts whole hammer rail by pneumatic, controlled by marginal perforation. All organ features, with drums, traps, etc., operated by pneumatics subject to controlling switches actuated by marginal perforations. Pneumatic auto-

: sustaining pedal device similarly controlled.
, stop and re-wind after roll is finished op-
d automatically by pneumatic switches.
moval and Replacement. Organ feature re-
ble as above described. For tuning,
er box swings forward on loosening bolts
ıold it to piano plate. Pneumatic action also
vable; but this is not necessary for tuning.
ws are hung under key-bed and can likewise
moved, although this is not usually required
ny purpose.

PRATT-READ PLAYER ACTION CO.

WASLE UNIQUE

s mechanism is manufactured by The Pratt-
Player Action Co., of Deep River, Conn.,
: installed in various lines of pianos.
lows-System. Indirect variation system.
exhaust units and one equalizer. Special
of folding pedals. Exhaust units and equal-
hung separately on trunk channel board, and
boxes are mounted on channel board. Bel-
ystem carries motor and expression gover-

cker-Box. Carries an automatic take-up
device, for alignment of music roll, on left

of tracker-box, with single pneumatic. Tubing is rubber. Automatic brakes for music roll and take-up spool, operated pneumatically.

Pneumatic Action. Double valve. In Style A, the pneumatics are in two banks facing forward, and attack on the piano action abstract by means of a lever, or auxiliary key, underneath. Vertical primary facing rearwards and horizontal secondary facing forwards, on same frame, all massed in two banks, each pair below its pneumatics. Vents massed on separate rail above top bank of pneumatics, facing forward.

In Style B, the pneumatics are in two banks facing rearward, and attack on a regulating button in the wippen. Vertical primaries massed in two rows on top of pneumatic action, underneath tracker-box rail, with horizontal secondaries above pneumatics; vents massed on separate rail at top and rear of pneumatic action.

Motor. 5-point motor pneumatic. Mechanical gear-shift controlled by re-wind lever.

Governing Devices and Control. Double divided soft pedal device, with pneumatic lifting hammer-rail; controlled by buttons on key-slip. Expression governor on right hand side of bellows-system facing forward, controlling valve box

on t› ›› left hand side. Lever on key-slip controls acce t-valve, and same box contains action-cut-off ‹ ‹lve actuated by re-wind lever. Motor governo is behind expression governor and controls mot‹ · valve box at top right hand side of bellows, faci‹ ; forward; is actuated by tempo lever.

Si ›nt drive device, actuated by re-wind lever. Aut‹ natic sustaining pedal pneumatic mounted unde neath key-bed at bass end of piano.

R‹ noval and Replacement. Top action is remov‹ l by loosening large screw bolts at each end, disc‹ nnecting wires and brace to piano plate. Tem o indicator connection and motor tube need not e touched. Bellows-system is removed by disc‹ nnecting suction tubes, and wires, and loos‹ ning screws in angle irons at top of bellows.

Price & Teeple Piano Co.

symphonola and harmonola

Tl › mechanisms known by the above names are man factured by the Price & Teeple Piano Co., Chic go, for their own exclusive use. The following description applies to both.

B‹ lows-System. Indirect variation. Two exhaus ›rs and two equalizers, high and low tension. Adj› ›table torsion springs on units, with ratchet

adjustment. Motor and expression governors carried on bellows-system.

Tracker-Box. Tracker-bar is manually shiftable for transposing of keys and carries automatic single-pneumatic tracking device, controlled by flange bearing against paper on left side. Thumb nut adjustment also provided. Automatic sustaining pedal perforation and on-and-off switch.

Pneumatic Action. Single-valve system. All valves mounted on chest at top of action, immediately below tracker. All valves can be withdrawn separately by taking off hard rubber ring on top of each. Valves have metal seats. Pneumatics are mounted below on three parallel metal bars, each pneumatic being adjustable for position. Rubber tubes from valves to pneumatics. Vents are massed in one row on brass tube running immediately below tracker, and have screw adjustments. Action mounted on metal brackets set into key-bed.

Motor. Six-point pneumatic with three double units and three double valves. Mechanical gear shift. Tempo valve carried on level with motor, and fastened at side of piano. Is made of metal, containing rotary metal valve.

G verning Devices and Control. Sustaining ped: pneumatic for automatic operation and direct finger lever for manual operation. Double divi ed hammer-rail pneumatics contained below key- ed and controlled by finger-buttons on key-slip. Expression governor with coiled spring adjust ient, carried on bellows together with action cut- ff box. Motor governor with coiled spring adju stment carried on bellows and containing mot r rewind valve. Tempo and rewind control d by combination lever.

R moval and Replacement. Pneumatic action can e removed by disconnecting two rubber tubes (au matic sustaining and tracking device tubes) and aking out two bolts, one at each end. Action is tl n tipped back, drawn forward and taken out. Bell ws comes out in one piece by pulling up two spri g latches and disconnecting four rubber tube .

The Schumann Piano Company

SCHUMANN

The Schumann piano player mechanism is the product of the Schumann Piano Company of Chicago and is used exclusively in connection with the line of pianos manufactured by that company.

Bellows-System. Indirect variation type. Made in two separate halves, each containing one exhaust and one equalizer unit. Also containing accenting device, making it possible to accent through the pedaling. Either half of bellows-system can be disconnected from the other and permitted to swing forward on pivots towards the front of the piano. Folding pedals pitched to obviate toe action.

Pneumatic Action. Single valve system. Horizontal valve with aluminum stem and fibre and leather disk. Regulating system for lost motion.

Tracker Box. Carries pneumatic tracking device on top of box, operated through finger lever on key-slip. Transposing Tracker Bar, transposing into six keys.

Motor. 6-point, units are in three tandem sets. Double acting slide valves.

Governing Devices and Control. Motor governor with jack-knife cut-off valve on top of pneumatic action, left side. Tempo lever governing same and re-wind lever connecting motor governor and valve box with action-cut-off valve.

Stop device to stop motor operated by button on key-slip. Double divided hammer-rail lifting

pneumatics controlled by buttons on key-slip. Pneumatic damper lifter for sustaining pedal operated by button on key-slip.

Removal and Replacement. Bellows-system removable in either of two halves, by disconnecting hose, rods, and thumb screws at either top end and swinging forward. Pneumatic action removed by disconnecting tubes and rods and releasing screws at ends.

M. Schulz Co.

This player mechanism has been developed by the M. Schulz Co., Chicago, and is used exclusively in the line of pianos manufactured by them. It contains many features of interest and some novel applications of principle.

Bellows-System. Direct variation. Two exhausters. One equalizer. Pedal leverage designed to eliminate "kick." Bellows are distinguished for simplicity of design, and cleanness of appearance. Action-cut-off valve box and motor governor with tempo-box are carried on bellows trunk.

Pneumatic Action. Single-valve system with novel form of bellows-valve, balanced and weighted, carrying vent in its head. Each valve is

immediately above its corresponding pneumatic. Valve boards forming reduced pressure chamber are detachable, each with its row of valves. Special regulating screws are provided for regulating touch depth and taking up lost motion between pneumatics and piano action. The whole action may be detached in one piece by removing 4 screws and one brace.

Tracker Box. Immediately above pneumatic action. Can be detached completely from the latter, carrying tracker-tubes and motor with it. Tracker-bar is provided with two-pneumatic type of automatic tracking regulator. Rubber tubing. Tracker box is detached by removing screws in front of pneumatic action, thus detaching front muffler board, and then removing rubber tubes from metallic nipples on top of action. Guide rail holds tubes in proper position for replacing.

Motor. 5-point pneumatic. Mechanical transmission gear. Slide valves run on guide rails.

Governing Devices and Control. Motor governor of bellows-type on front bellows-system. Has double spring system and regulating screws. Tempo box behind governor and action cut off at bass end of key-bed. Double divided hammer rail lift for soft pedal controlled by direct mechanical

lever action or by pneumatics governed by buttons. Direct lever control for sustaining pedal.

Removal and Replacement. Accomplished as above. The whole action is in three large sections, each removable separately. All parts are interchangeable.

The J. P. Seeburg Co.

SEEBURG

This mechanism is manufactured in a line of pianos by the J. P. Seeburg Co., of Chicago. It is of the coin-operated automatic type. Besides the straight player-piano there is also in this line an orchestrion with pipes of various voicings, drums, cymbals, etc. There is also a player-piano with a scale of organ pipes added.

Bellows-System.—Electric-motor-driven double exhaust units. Where organ pipes are used, waste air after escape from exhausters is turned into organ wind trunk. One equalizer.

Tracker-Box. Below key-bed. Friction drive from bellows driving music spools. Speed governed by thumb-screw under key-bed. Rubber tubing.

Pneumatic Action. Single valve.

Governing Devices and Control. Expression

governor in equal zer frame controlling high or low tension throug i manual lever on front of shaft. Coin-operated ma n switch, pneumatic control. Marginal perforations in tracker-bar controlling pneumatic sustaining pedal device, pneumatic soft pedal device, pneumatic operation of mandolin rail, pneumatic stop at end of each piece and pneumatic re-wind at end of roll. Organ pipes tuned by test roll in unison with strings. Drums, cymbals and other features are operated by pneumatics through special perforations in rolls, with manual operated cut-offs to each.

Removal and Replacement. When tuning, pipes are removed individually. In orchestrions the whole Drum Board with drums and trap arrangements mounted thereon can be removed in one piece by removing screws at each end. Pneumatic action can be taken out in one piece.

The Simplex Player Piano Co.

THE SIMPLEX

The mechanism manufactured by this company is made by them for wholesale use.

Bellows-system. Indirect variation type. Expression (2) and motor governors are carried on bellows frame.

Tracker-Box. Carries hand-operated roll adjuster for correction of tracking. Horizontal tracker bar.

Pneumatic Action. Both double and single valve type. Special type of secondary valves with hinged disk.

Motor. 5-point pneumatic. Single Units. Mechanical transmission of gear-shift.

Governing Devices and Control. Expression governors for bass and treble divisions of action. Suction is normally carried through these governors, so that playing is normally soft. By pressing buttons located on key-slip, valves are thrown upward in governors, opening suction passages independent of governor. This allows for accentuation. Governors can be cut out entirely by lever which keeps buttons in operating position and thus holds valves open. Expression governors are located at left side of bellows-system. Sustaining pedal device is either pneumatic with operating pneumatic and button or manual with finger lever. Hammer-rail lifter pneumatic also used, controlled by button. Tempo and re-wind levers control motor valve-box located at right side of bellows, together with motor governor.

Removal and Replacement. Bellows-system

can be removed in one piece with all governors, etc., by disconnecting tubes and levers and taking out thumb-nuts. Top action can be removed by loosening screws at either end of same and disconnecting tempo lever connections to tempo indicator.

Standard Pneumatic Action Co.

This mechanism is manufactured by the Standard Pneumatic Action Co. of New York. The Standard Player Action forms the regular player equipment of many well known player pianos. It is designed for simplicity and reliability.

Bellows-System. Direct variation type. Two exhausters, and two equalizers. Folding pedals. Auxiliary accenting valve.

Pneumatic Action. Double valve type. Vertical primaries and horizontal secondaries in separate chests. Vents accessible from front of primary chest. Wind trunk connection to bellows.

Tracker-Box. Tracker-bar has marginal perforations for automatic tracking device. Automatic tracker is at left side of tracker-box and contains two horizontal pneumatics with double valves. Tracker duct tubes are metal.

Motor. 5-point pneumatic. Mechanical trans-

mission and re-wind gear. Motor can be thrown forward without removing for tuning purposes.

Governing Devices and Control. Motor governor of open jack-knife cut-off type is located in front of bellows near right side. Contains also motor valve box, controlled by tempo lever and containing motor re-wind valve controlled by re-wind lever, which also controls action cut-off. Finger lever making direct mechanical connection to damper lifter for sustaining pedal effect and direct finger lever hammer-rail lifters operating mechanically, on divided hammer-rail.

Removal and Replacement. Top action is removed by taking out screws which fasten action to trunk passage at left side, and end fastening screws. Bellows come out in one piece by removing large fastening screws at each side and disconnecting rods and hose. Tuner need not remove top action to tune.

Steger & Sons Piano Manufacturing Co.

STEGER NATURAL PLAYER

This mechanism is manufactured by the above-named concern for their exclusive use.

Bellows-system. Direct variation. 2 exhausters and 2 equalizers, high and low tension. Motor

governor, motor valve and action cut-off boxes are carried on bellows frame. Special folding pedals.

Tracker Box. Carries tracking device operated manually by thumb nut at left side. Tubing to valves is metal; in older models sometimes rubber.

Pneumatic Action. Pneumatics are placed forwardly and operate rocking levers to piano action. Valves are accessible and individually adjustable from front.

Motor. 5 point pneumatic, single units. Mechanical gear shift.

Governing Devices and Control. On newest models all control levers and buttons are massed on shelf which pulls out from under key-bed, locking keys in same operation. Some models have left thumb lever for lifting entire hammer-rail. All have double divided hammer-rail lifting pneumatics disposed in front of rail or at side of piano action, controlled by finger buttons on shelf or keyslip. Left little finger lever direct connected to damper lift rod for sustaining. Tempo lever controls slot in box on bellows frame at right side, next to tempo governor of bellows type. Action cut-off valve is in action cut off valve box at left side of bellows and together with motor rewind

drive valve in motor valve box is controlled by rewind lever.

Removal and Replacement. Pneumatic action and motor come out by removing large bolts at either end, disconnecting motor tube and tempo indicator rod. Bellows system is removed by unscrewing metal supports in front of exhausters, disconnecting rods and withdrawing.

The Sterling Co.

The Sterling Player mechanism is manufactured by the Sterling Co., of Derby, Conn., and is of their exclusive design, being fitted only to their own line of pianos.

Bellows-System. Indirect variation type. Two exhausters, one equalizer. Bellows frame carries motor and expression governors. Motor and expression valve boxes are carried above, fastened to the underside of piano key-bed.

Pneumatic Action. Double valve type. Primary pouches are in form of small diaphragm pneumatics, with the vent to each sunk in its upper surface. Secondaries are immediately beneath and vertical. Pneumatics have operating ends toward front of piano and actuate rocking

levers which engage with abstracts of piano action.

Tracker-Box. Contains tempo indicator. Thumb-nut for correcting position of music-roll. Tracker-duct tubes are rubber.

Motor. 5-point pneumatic. Mechanical transmission gear with special non-blocking take-up spool cog.

Governing Devices and Control. Expression control, as stated above, through bellows governor and expression valve box controlled by accent lever on key-slip. Hammer-rail lifting pneumatics above hammers at each end of scale, controlled by buttons on key-slip. Motor governor as stated above with motor valve box fastened on under side of key-bed at right end, controlled by tempo lever. Re-wind lever controls re-wind motor valve in motor box and action cut-off in expression box at left end.

Removal and Replacement. Bellows-system comes out by taking out screws at each end, disconnecting rods, hose and pedals. Top action is removed in exactly similar manner.

Tel-Electric

This mechanism is manufactured by the Tel-Electric Co. of Pittsfield, Mass., and may be installed in any type of upright or grand piano.

On account of the original system on which this mechanism is designed and constructed, it is necessary to adopt for its description a special method; as follows:

Principle of Operation. A series of magnets is suspended in a shallow box underneath the key-bed of a piano. Each magnet is connected with a key of the piano by means of a wire running from the bottom of each key through the key-bed to the armature of the magnet. When energized, the magnetic field influences the armature, which turns pulling down the wire and operating the key.

Selection and Control. A control box is provided, connected with the piano only by a cable running to the box of magnets. This control box may therefore be operated at any distance from the piano, within the length of the cable. The control box contains a delicate motor for turning the music roll. The latter is a narrow continuous strip of brass, about five inches in width and

wound on a spool. The tracker-bar contains delicate contact-points and the circuit is completed for each by the incidence of perforations in the roll. A rheostat of special design controls the force of the current and consequently the force of touch, while a similar device controls the motor speed. Both of these elements may be controlled by hand or by automatic electric devices controlled by the roll.

Vose & Sons Piano Co.

VOSE

This mechanism is used in the Vose piano exclusively, being manufactured by Vose & Sons Piano Co.

Bellows-System. Indirect variation. Two exhausters and one equalizer. Special folding pedals.

Tracker-box. Carries automatic tracking device with two pneumatics under box, and marginal perforations. Automatic sustaining-pedal perforation opened and closed by switch. Tubes are rubber.

Pneumatic Action. Double valve system.

Motor. Five-point pneumatic, with mechanical gear shift.

Governing Devices and Control. Sustaining pedal pneumatic at left of bellows under key-bed, with automatic perforation in tracker-bar and finger button on key-slip. Double divided hammer rail lifting pneumatics above action at right and left sides. Expression governor controlled by finger lever on key-slip, at left side of and behind bellows system, carried separately on sides of piano. Expression governor is of bellows type with adjustable coiled spring. Action cut-off carried in same box. Motor governor and motor valve box at right side behind bellows, carrying tempo-slot and rewind drive valves. Tempo lever on key-slip. Rewind lever on key-slip. Key-lock actuated by pulling down key-slip. Auxiliary tempo-valve in tempo-valve box, actuated by finger plate on key-slip.

Removal and Replacement. Pneumatic action can be removed by disconnecting rods and taking out large screws, one at either end. Bellows-system is removed by doing exactly the same thing.

M. Welte & Sohn

This mechanism is manufactured by M. Welte & Sohn of Freiburg, Germany. It is constructed both as a separable cabinet which may be placed in

front of any grand or upright piano or as an interior attachment placed within a modified upright piano case. It is intended solely as a reproducing player, using rolls which record the performances of artists. Hence the following description is general in character.

Bellows-System. Is driven by an electric motor and contains a set of exhaust units with equalizers, expression governors and similar devices.

Pneumatic Action. Double valve system. Welte type.

Expression Devices and Control. A rheostat, controlled by pneumatic switches operated by marginal perforations in the roll, governs the speed of the electric bellows motor, and so controls the vacuum tension. Divided pneumatic hammer-rail lifters and pneumatic sustaining pedal device operated by marginal perforations. Expression governors for controlling accent operated in similar manner. Entire operation is automatic, controlled entirely by record roll. Starting, stopping and re-wind of motor controlled automatically by pneumatic switches controlling electric cut-outs. Tempo is governed by phrasing of rolls, which are records of the playing of individual artists.

Some models are placed in key-board-less pianos, while others are fitted into enlarged upright piano cases, having the pneumatic action above the hammer-rail. For grand pianos, the cabinet type is used.

Weser Bros.

This mechanism is manufactured by Weser Brothers, New York, and is used exclusively in the line of pianos manufactured by that firm.

Bellows-System. Is fitted with both foot-pedal and motor driven exhaust units, so that operation may be either personal or automatic as desired. Self-dropping pedals of special folding design.

Tracker-Box. Carries automatic tracking device and threaded guiding wheel, whereby any width of music roll can be accommodated.

Pneumatic Action. Single valve type. Flexible contact between pneumatic and piano action. Pneumatic action massed in three banks. Metal cap vents in front immediately accessible by uncovering valve chest cover. Lost motion regulation on pneumatic and regulation for touch depth of same on regulating rail in front of piano action abstracts.

Governing Devices and Control. Automatic

hammer lift working from equalizer wall. Double divided hammer-rail lift operated by buttons on key slip. Accent lever working on expression box and sustaining lever operating direct mechanical action of damper lifters. Tempo and re-wind controlling valves in motor valve box and action cut-off.

Removal and Replacement. Both bellows-system and pneumatic action are removable immediately in unit form, the former without the use of screw-driver. It is not necessary to remove pneumatic top action to tune the piano.

Wilcox & White Co.

THE ANGELUS

Manufactured by The Wilcox & White Co., Meriden, Conn. The Angelus is made for both upright and grand pianos and is also made in cabinet form. It contains many exclusive features which have gained for it widespread fame. The Angelus is incorporated regularly in several pianos.

GENERAL DESCRIPTION

Bellows-System. Indirect variation. Two exhaust units and one equalizer. The bellows-system carries the sustaining pedal pneumatic

and motor governor. Expression control pneumatics for the bass and treble ends of the action are located at each end of the piano case below keybed.

Pneumatic Action. Above keybed. Double valve system. Pneumatics are of the diaphragm type, being inflated instead of exhausted for operation. This system is peculiar to the Angelus. The diaphragm pneumatics act on lifters which engage the abstracts of piano action.

Tracker Box. This is located immediately above pneumatic action. Contains tempo indicating dial. Tracker tubes to primaries are of a special composition. The Angelus may also be fitted with a duplex spool box and tracker, whereby both 65 and 88 note music rolls may be used. Is also fitted with lever for aligning note perforations with ducts in tracker-bar.

Motor. Five-point pneumatic. All units in a straight line. Placed above keyboard of piano on level with top of tracker box.

Governing Devices and Control. Motor governor is controlled by a phrasing lever, whereby the air exhausted from the motor is at all times under perfect control of the performer. The motor governor also contains the ordinary tempo

valve connected to the tempo lever on the front edge of key-slip. All other expression levers are also located on the front edge of the key-slip and when not in use are covered by the folding key-slip. The opening of the key-slip causes the foot pedals to fall into player position. Folding up the key-slip and giving one or two depressions to the foot pedal causes them to retract into the piano case, so it is not necessary to stoop and fold the pedals when the instrument is to be closed. Re-roll lever controls action cut-off valve, which is situated in the equalizer. The same lever also controls the re-roll valve in the motor governor. Two expression control pneumatics for divided action are incorporated in the Angelus and the emphasizing of the melody notes can be done either by the buttons actuated by the fingers of the left hand or the melody notes may be automatically emphasized by the melodant, actuated through primary and secondary valves so that when the small marginal perforations in the music roll register with ducts in the tracker, the melody note which has been advanced slightly on the special roll, is sounded at high tension, with the accompaniment notes following at low tension, the operation

being made possible by the advancing of the melody note, thus giving time for the melodant perforation to pass the tracker, opening and closing the special by-pass in expression governor. The graduating accompaniment lever operates a by-pass valve so that a crescendo or diminuendo effect may be given to the accompaniment notes. The graduating melodant lever affects the volume of the emphasized notes. One lever controls the graduated melodant, the graduating accompaniment and the melodant. The sustaining pedal lever can be worked by the thumb or automatically by means of perforations in the note sheet through a pneumatic.

Removal and Replacement. Top action is removed by extracting the supporting screws and disconnecting the re-wind and tempo lever wires. Bellows system easily removed for inspection if necessary.

Angelus Grand. Is exactly the same as above except that it is adapted to grand pianos. The Angelus action is behind the fallboard of the piano and contains the diaphragm pneumatics. The bellows system is fitted under key-bed between the posts of the piano and is completely hidden. Foot pedals are contained in the bottom part of

the lyre, into which they fold when not in use. All of the features described above are found in the Angelus Grand.

Cabinet Angelus. Same as above, but fitted into cabinet case so it may be placed in front of any piano.

Orchestral Angelus-Piano. This piano contains a set of organ reeds in addition to the pneumatic action and is also fitted upon special order with a mandolin attachment. The organ reeds may be played from the manual keys of the piano or from the music roll, and the reeds and piano may be played separately or simultaneously.

Winter & Co.

This mechanism is manufactured by Winter & Co. of New York, and is used by them exclusively in their pianos.

Bellows-System. Indirect variation type. Two exhausters and equalizers. Bellows carries expression and motor governors.

Tracker-Box. Carries automatic tracking device.

Pneumatic Action. Double valve type.

Motor. Pneumatic type. Mechanical gear shift.

Governing Devices and Control. Expression governor with expression valve box controlled by finger lever. Finger sustaining lever with direct mechanical action. Double divided hammer-rail lifters controlled by buttons on key-slip. Tempo and rewind levers operating in motor and expression boxes to control tempo and rewind motor valves, and action-cut-off valve.

Chapter I.

THE MUSIC ROLL.

The scope of the present work demands no more than briefest mention of the music-roll. This is not because that element of the piano player is not important, but because almost everything about it is sufficiently obvious of itself. There are some points, however, that are worth comment.

Essentially, the music-roll is a sheet of paper, wound upon a spool, of standard width, and perforated with holes which represent positions on the tracker-bar of the player mechanism occupied by ducts corresponding with the playing pneumatics. The method of perforation differs among various manufacturers, but in general it consists of laying out on paper the notes of a composition in lines which are identical in length or have a definite ratio thereto with the perforations which are to be produced later. The length of each line is determined by the time-value of the corresponding note on the score. Each duct

on the tracker-bar corresponds, as it were, with one key of the piano, and so each perforation on the paper must have a definite position according to the particular note it represents. Hence, by means of a scale, the arranger is able to place his pencil lines in the right positions. The precise basis of length upon which the arranger proceeds differs according to his judgment of the speed at which the roll should travel over the tracker-bar. Thus pieces which are to be played with slow effect are always laid out on a longer basis than such as are to be played rapidly. There are many other details, of course, but these belong to the domain of the arranger.

The notes having been laid out in this manner, the pencil lines are punched out, and the resulting "master-sheet" is used for the reproduction of rolls by means of the perforating machine. The latter may be pneumatically or electrically or otherwise operated.

All in all, it can hardly be said that the music-roll has kept pace with recent improvements in player mechanism. Nor is this to be wondered at, for the ideal roll is perhaps pretty nearly impossible of achievement. Nevertheless, there are

looking towards the further improvement of the music-roll which cannot be lightly dismissed. The object of these is to bring the roll into a position where it may the more rightly fulfill its functions as the controller of the player-piano and as the substitute for the pianist's score.

The most important of these movements is exemplified in the so-called "record-roll." Here we have a picture of the playing of a certain pianist, recorded from his actual work at the piano and reproduced in the form of a roll. Such records, of course, are not yet brought (except in the case of one instrument) to the point where they afford reproduction of the artist's tone-shading, accenting and dynamics, but are confined to reproducing his phrasing and pedal control. That is to say, the record shows what keys were pressed by the artist, how long each was held down, and how he manipulated the sustaining pedal. Even so, they have a great value as guides to the amateur, who thereby may obtain an excellent view of the artist's conception regarding any particular piece of music.

Of course, there is another side to these rolls; one not so obviously advantageous. It is contended by many that the record-roll is a step back-

ward in that it takes away from the player-pianist all necessity for personal phrasing and coloration and therefore tends to turn him into a mere automaton, thus destroying the musical value of the player-piano as an instrument for personal interpretation. The objection is probably rather academic. The future of the record-roll is no doubt certain, and its career will decidedly be interesting.

Other attempts have been made to improve the roll in its capacity of musical guide. The metro-style markings are familiar to all, and the artistyle indications have also obtained fame. The object of all these is to give the amateur a guide to phrasing or dynamics without taking away from him the power to impart his own interpretative ideas at will. Generally speaking, expression lines, special markings for phrase changes and more careful editing than ever are to-day the commonplaces of all music-rolls.

The old idea that an arranger must alter the scores in order to render them more pleasing when played by the player-pianist has almost entirely disappeared with the advent of the 88-note player-piano and roll. When the 58-note and 65-note ranges represented the greatest heights to which

player mechanism had risen, scores were often very meagre when compressed within these limits. To-day, however, the full-scale roll has eliminated all necessity for re-arrangement, and therefore for embellishment, especially of the sort that so often disfigured music-rolls in the old days.

A recent addition to music-rolls is the sustaining pedal perforation, which is now becoming a recognized part of the complete product. Here, the arranger, or (in case of a record-roll) the pianist himself, indicates the places where the sustaining pedal should be put on and off, which indications are later reproduced in the form of perforations at the left or bass margin of the roll, registering with a duct leading to the pneumatic which operates the damper lifter. Other marginal preforations to be found on the music-roll are for the automatic accenter when such is present and for the automatic stop and start pneumatics when the roll is designed for a coin-operated or similar instrument.

The Buffalo conference of 1909 settled definitely the dimensions of music-rolls for all time, and thus introduced an element of certainty that before had been lacking. The agreements made at this time settled all dimensional questions thor-

oughly, and established once for all the scale of nine perforations to the transverse inch. Player manufacturers therefore are able to make their trackers to an absolute standard and may remain confident that any music-roll made to-day will fit them perfectly.

The original wooden spool and flanges of the music-roll have been almost entirely abandoned in favor of hard-rubber or metal flanges and cardboard spools. Moreover, the paper itself has been greatly improved with respect to its ability to resist the influences of moisture and dryness, so that shrinking and swelling no longer are to be dreaded as once they were. In fact, the automatic tracking device to-day might almost be dispensed with, although when it was introduced nothing seemed to be more necessary.

It is not probable that the immediate future will see any really marked changes in the make-up of music-rolls. Such changes as do occur will probably be along lines already laid down, and while we may look for greater reliability, greater care in arranging, and greater uniformity in mechanical structure during the next few years, it is hardly to be expected that any radical improvements will be heard of.

Chapter II.

Coin-operated, reproducing, and electric mechanisms.

Coin-operated Player-pianos.

The principles upon which coin-operated instruments are constructed are the same as have already been so fully discussed in previous chapters. Such differences as exist are to be traced entirely to the fact that the coin-operated player-piano is an instrument in which every needful function is performed automatically, by machinery that needs no human intervention. Since the pneumatic principle is retained, the coin-operated player-piano differs from the ordinary player only in that it has attached to it a number of auxiliary devices for automatic stopping and starting, and for automatic operation of the soft and loud pedal devices of the piano, together with such precautionary attachments as may be necessary to protect the coin-operating feature from harm.

It is obvious that the power to run the bellows

must be provided in some form capable of adaptation to the space limitations of the piano. An electric motor is consequently employed, and since it operates the exhausters at much higher speed than is possible with the human foot, the latter are always made considerably smaller than with the ordinary player-piano. It is customary to use three exhausters arranged on one trunk, fanwise. Inasmuch as the expressiveness of the automatic piano is not a matter of immense importance, it is possible also considerably to simplify the whole bellows-system.

The roll driving motor of the automatic player sometimes follows standard practice, but the system is becoming common of driving the take-up spool and chucks direct from the electric motor, through a transmission gear. Sometimes a friction gear is used, in which case the change from forward drive to re-wind is very simple.

Starting and stopping can of course be controlled through perforations in the music roll, operating on valves and pneumatics adapted to make or break electric contacts.

The valve and pneumatic action of these automatic player mechanisms is always planned for simplicity and durability in the face of hard work,

rather than for delicacy and refinement. To-day the tuner or repairman finds in such instruments as the Peerless, the Seeburg or the Cremona wonderful strength and simplicity, combined with a capacity for standing up under strain which can only be called amazing. In earlier days this condition of affairs was not so frequent by any means, and old style instruments of the coin-operated type are, therefore, usually rather puzzling to the inexperienced repairman. Nevertheless, it is quite proper to say that nobody who has read carefully the first two parts of this book need be afraid of anything at all in the way of coin-operated pianos, if only he will use his common-sense. A thorough understanding of pneumatic mechanism is better than all the directions that one could give in an hundred pages.

The only point, in fact, which requires any further statement here has to do with the electric motor and its connections. The manufacturers of coin-operated instruments invariably send out with their instruments full directions for the care of such motors, which indeed seem to be almost fool-proof, judging by what they have to undergo and how they stand up under the strain of use.

One more point: The music-rolls used for coin

operated instruments differ somewhat from the usual style. Some of them are continuous, winding over the tracker in an endless belt, and containing several selections, which are thus repeated over and over again. Others are wound on very large spools which re-wind automatically when the whole is played through. The tuner or repairman will have no difficulty in handling any of these features, however, if he will but keep in mind that the pneumatic principles are the same as in any other player and that the controls are automatically operated through marginal perforations in the paper.

The Welte Piano.

This very remarkable instrument deserves special mention, although it belongs, in essence, to the same mechanical type as the coin-operated player-piano. The Welte is a player mechanism which comes in three forms: (1) as a cabinet, (2) in combination with a key-board-less piano, (3) in combination with a piano of regular style. Fundamentally it is a pneumatic player mechanism, operated automatically in all its functions, and reproducing the precise characteristics of the playing of some artist. The rolls used on the

Welte are made direct from records produced by the actual playing of pianists at the key-board of a piano. The rolls themselves, therefore, contain the artist's characteristic phrasing, in that each perforation is exactly of a length corresponding with the time the note was held down by the pianist's fingers on the key. The position of each perforation in order of succession likewise directly corresponds with the artist's phrasing.

But the Welte does more than this. It approximates, with marvellous fidelity, the pianist's attack, dynamic control, and pedaling. The bellows-system is operated by an electric motor, and the dynamic intensity of the key-attack is controlled by a series of marginal perforations in the roll and tracker, which control pneumatics whereby the speed of the motor, and consequently the pressure level, may be altered instantly, and as rapidly as desired. Starting and stopping are also controlled by pneumatic means.

The artistic possibilities and achievements of the Welte are practically unlimited. Its technical details may be easily understood, when examined in the light of the general instructions contained in this book. It may be regarded for mechanical purposes as a highly refined and de-

veloped type of automatic player, without the coin feature, and with automatic expression controls of an eminently efficient nature. Its fine workmanship, and the obviously high skill of its makers will provoke the admiration of every good mechanic. The Welte is a German instrument, and was developed by M. Welte & Sons, of Freiburg, who have for many years been eminent as builders of automatic pipe-organs and similar instruments.

Other Automatic Players.

Germany, for some reason or other, has been especially forward in the invention and development of player mechanisms of the reproducing type; that is of mechanisms which are intended to serve as the means for the reproduction of some person's performance, and not as a vehicle for personal interpretation. The Welte is perhaps the most famous of these, but it would be wrong to pass by so ingenious and remarkable an instrument as the so-called "Phono-Liszt Violina." This piece of ingenuity is the product of the great house of Ludwig Hupfeld, and consists essentially in the combination of a reproducing player-piano with a very ingenious automatic violin player.

The latter employs three regular violins and by means of most ingenious pneumatic arrangements causes the approximation in marvelous fidelity of such refinements of violin technic as the staccato, the vibrato, the pizzicato, and so on. A bow of horse-hair mounted on a ring which revolves outside and in contact with the violins is the sound-producing medium. The approximation of personal violin playing is really wonderful.

The same house (Hupfeld) are also responsible for a successful cabinet reproducing player, like the Welte, and for a player-piano interior mechanism, adapted for both uprights and grands, containing many ingenious refinements, but which is not at present (1913) in use in the United States.

Electric Player Mechanisms.

It has often been supposed that the electric current would sooner or later assume first place in the affection of player inventors. So far, however, the attention of designers has been almost entirely concentrated on the pneumatic system. And there are good reasons for this. The electric energy, in any shape in which we can at present employ it, and with regard to any particular sort of mechanism which we can devise for its use, is

not yet susceptible to the sort of control which is ideal for the player-piano. That control is above all things required to be flexible, to such a degree as is unknown in any other sort of machinery. Precisely here electric machinery is at fault.

Nevertheless, there are two types of electric mechanism which have survived the struggles and storm of the last few years and which appear to be on a firm foundation. Neither, so far as concerns detailed technical description, have any large interest for the readers of this book. The men who should repair or regulate them are the experts from the manufacturers' shops. But a general idea of their make-up and methods cannot fail to be interesting.

The first of these which we shall consider is the Tel-Electric. Essentially this consists of a series of magnets, assembled underneath the key-bed of a piano and connected each with one key thereof. The magnets are energized through a controlling box over which travels a brass perforated roll about 5 inches in diameter. This roll makes and breaks contacts with the magnets. A small and delicate electric motor is provided to wind the roll, and by means of delicate resistance apparatus can be controlled as to speed by the per-

former. Similar devices are used for increasing or decreasing the force of the energizing current, either automatically through the roll, or at the will of the performer, whereby dynamic degrees can be controlled and accents placed, appropriately.

The Tel-Electric mechanism is peculiar in that the controlling box is detached from the piano, being attached to the magnet box only through a flexible cable. Thus the performer may sit at any required distance from the piano while playing. Either upright or grand pianos may be fitted with the Tel-Electric mechanism. The expressive capacity of the Tel-Electric has been greatly enlarged and refined in the last few years and the mechanism now begins to compare favorably with other types in these important respects. The ordinary light current may be used to operate this player or, in the absence of current, storage batteries are available. The consumption of current is very low.

The Electrelle is also an electro-magnetic mechanism, but its operation is somewhat different. Essentially it consists of a line of small magnets, which when energized throw forward shoes, which catch upon a revolving rail and are held in place

until the contact is broken. The shoes are connected with the piano action and operate it directly. The mechanism is placed above the key-bed of the piano. The tracker-box slides out of sight, when not in use, beneath the key-bed, whence it can immediately be withdrawn for playing. The performer sits in front of the piano, with his hands resting upon the control levers on the tracker-box, and his feet on the piano pedals, which he employs just as does a manual pianist. The tracker-box contains a bar which is electrically energized, and above that a series of small contact brushes, one for each magnet, spaced so as to conform with the nine-to-the-inch scale of the paper roll. Regular rolls are used. When the paper is unperforated it acts as an insulator between bar and brushes, but when a perforation appears it permits the corresponding brush to touch the bar and complete the circuit for that particular magnet. The revolving rail is actuated by a small electric motor, which also turns and re-winds the roll, its effect upon the latter being governed (for tempo) by a delicate brake under the hand of the performer.

The expressive capacity of the Electrelle apart from its phrasing control noted above, is provided

by a device which is not electric and which can be (as it has successfully been) applied to pneumatic mechanisms also. It consists of an auxiliary hammer-rail, in three sections hinged together, and operated by three finger-keys in such a way that the line of hammers may be bent into any desired shape, thus permitting the performer to bring any hammer as near to the strings or as far from them as he desires. In this way, the stroke of any hammer may be lengthened or shortened and the tone-force controlled absolutely. When the device is in use, the hammer-line is moved up closely to the strings and the manipulator proceeds to lengthen their stroke as required by pressing the keys downwards, or to shorten it by letting them up. Each key controls one of the hinged-together sections, and by combining the key movements all sorts of combinations may be effected. In fact, two separate and distinct accents may be obtained at one time, over the general level of sound. This flexible control is highly efficient.

Electricity provides a form of energy which in every line of activity is rapidly superseding all rivals. In the case of player mechanism, the electro-magnetic principle is the only one that has

yet been tried. But it is not the only possible one. If the present difficulties are ever entirely overcome, the electric current will perhaps show its superiority over all other forms of energy in no uncertain way. When that time comes, the pneumatic man will have to take a back seat. But that time is not yet here, nor can one say whether it will come.

PART V

GENERAL CONSIDERATIONS ON REGULATION AND REPAIR

Chapter I.

Manufacturers of player mechanisms now make a general practice of supplying technical catalogues describing the make-up of their actions, and pointing out the directions to be followed in repairing faults or maintaining efficiency. Inasmuch as every player mechanism has its peculiarities, it would be obviously impossible for me to give all the information in this chapter that would enable a tuner or repairman to learn the details of each player on the market. Nor is this necessary, in view of the abundance of literature already extant, as above remarked. But there is one thing that can and should be done in this place. Just as the technical catalogues of manufacturers do not and cannot take the place of a general treatise like this, so also the statements on regulation and repair which are contained in those booklets require to be supplemented by some remarks of a general nature, intended to give the tuner or repairman a better understanding of the larger elements in the problem, but not attempting to specialize.

Certain general principles ought indeed to be observed by the tuner or mechanic who under-

takes to repair all makes of player mechanism. Incidentally, it might be said that an excellent habit is to carry in the tool-case copies of the technical catalogues issued by the different player manufacturers. The whole bundle makes a small package, and the advantage of having at hand always such precise information is greater by far than any trouble involved in carrying the booklets around. Every one of the systems treated in this book has been technically described by its manufacturer and the principles and practice of regulation and repair set forth.

No tuner should ever approach a player-piano without a test-roll. No matter what may be the nature of the complaint, the test-roll is the only certain indicator of trouble. It may be used to test motor speeds, motor defects, valve and pneumatic troubles, weaknesses in the bellows-system, leaks, and every other sort of difficulty that may conceivably present itself. This is a cardinal principle for every good repairman.

It will be well here to set forth a number of the principal symptoms of player trouble and explain their causes, with the means for setting them right.

1. *Repetition slow or sluggish.* Probably the

vents somewhere are choked. Clean out tracker-bar with a suction pump or expose vents and clean each one with a needle. Unless vents are open, pressure cannot be readily reduced in tracker-duct; a requisite to rapid repetition.

2. *Note speaks when pedals are operated but before perforation in paper registers with its duct.* This shows that the pneumatic is collapsing through faulty action of valves or through some cause that affects the valves. See if tracker-duct tube is disconnected, or valve disks held open by some foreign substance lodging under them. Lastly, look for any leaks in valve board admitting air to valves and operating them.

3. *Note does not speak when perforation appears.* This shows that pneumatic does not collapse. See what is preventing valves from working. See if air passages are blocked. Lastly see if pneumatic is defective or disconnected from its seat, or has its covering torn.

4. *Music plays while re-winding.* This shows that action cut-off valve does not work. Examine and remedy accordingly.

5. *Motor drags or races.* If motor drags on hard pumping, this shows that motor governor closes too much. Strengthen spring or adjust

regulating screw. The reverse action will remedy the difficulty if motor races under hard pumping.

6. *Music does not track.* If the player has an automatic tracker, examine to see whether the latter is working. If not, clean valves and try again. If there is no automatic tracker, adjust tracker-bar and try over with different rolls. See if rolls are in good condition.

7. *General weakness of action, lack of resistance to pedaling, inability to get accents, etc.* This invariably proves that the exhaust connections between bellows and top action are loose, or that the action is leaking somewhere. Examine and remedy accordingly. Especially see that valve boards are screwed down tight and look for any hair-line leaks in wooden boards. Stop these with shellac.

8. *General considerations on old player actions.* Player actions which are over five years old are likely to suffer from a multitude of maladies peculiar to themselves. This is because the interior player mechanism of that age or older is usually harder to get at, less durably made, and more complicated than its brethren of to-day. One special fact will always be apparent to the repairman,

and that is that the older a player mechanism is, the more leaky and porous it becomes. Not only so, but the pouches begin to get so weak and worn out that they almost fall to pieces when touched. A player action that is entirely worn out is something that had better be sent back to the factory for rebuilding. There is no satisfaction in working on a pneumatic mechanism which does not respond to gentle treatment.

Old actions will frequently call for repairs on pneumatic coverings, valve pouches, valve disks, motor slides and so on. Whenever an attempt is made to recover pneumatics or replace pouches, the best modern material should be used. In the case of motors, valves often swell and stick and must be planed back smooth with their seats.

Nearly all the older pneumatic mechanisms are hard to get at. The repairman must use his ingenuity to discover the secret of divorcing the piano from its pneumatic action, for oftentimes the task of disentangling is formidable. In chapter 13 of my Technical Treatise on Player Mechanism (published in 1908) much valuable information has been amassed concerning the peculiarities of contemporary player mechanisms, and

Do not allow incompetent piano tuners to touch your instrument. Be sure your tuner knows what he is doing.

Be sure and have your player-piano tuned at least every six months. This is necessary because you will use your player-piano so much more than you ever used a piano before.

Do not neglect to have the accumulated dust inside your player-piano removed at least once a year, at the same time having the mechanism examined for any needed adjustment.

Be careful not to expose your player-piano to extremes of heat or cold or of dampness or dryness.

When through playing each roll, see that the paper is lightly rolled up on its spool, snap a rubber band around it and replace it in its box. Half the supposed troubles complained of in player-pianos are due to rolls made defective through mishandling. In brief treat your player with the care which it deserves.